REPORT DOCUMENTATION PAGE

1. REPORT DATE (dd-mm-yy)	2. REPORT TYPE	3. DATES COVERED (from. . . to)
June 2002	Final	Jan 01- Jan 02

4. TITLE AND SUBTITLE	5a. CONTRACT OR GRANT NUMBER
Measuring Digital Proficiency: Assessment Approaches and Echelon Considerations	DASW01-99-D-0013
	5b. PROGRAM ELEMENT NUMBER 2O262785

6. AUTHOR(S)	5c. PROJECT NUMBER
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	5d. TASK NUMBER 234
	5e. WORK UNIT NUMBER C01

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)		8. PERFORMING ORGANIZATION REPORT NUMBER
TRW Inc. TRW Systems One Federal Park Drive Fairfax, VA 22033-4411	U.S. Army Research Institute for the Behavioral and Social Sciences Simulator Systems Research Unit 12350 Research Parkway Orlando, FL 32826	

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. MONITOR ACRONYM
U.S. Army Research Institute for the Behavioral and Social Sciences 5001 Eisenhower Avenue Alexandria, VA 22333-5600	ARI
	11. MONITOR REPORT NUMBER ARI Research Report 1791

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

Delivery Order Contracting Officer's Representative, Larry L. Meliza.

14. ABSTRACT *(Maximum 200 words)*:

Digitization threatens to overwhelm trainers with observation requirements, making it crucial to identify aspects of unit performance likely to warrant the attention of trainers and others with a need to measure unit digital proficiency. This report encompasses two approaches used to target high-payoff measurement objectives. First, the research team described differences between brigade and battalion echelons in terms of how digital systems are employed. This approach assumed that a high priority for brigade exercises is to address brigade-unique aspects of digital proficiency. Second, the team described how units can use digital systems to gain two of the major advertised benefits of digitization, reducing fratricides and gaining greater control over how and when contact is made with the enemy. In addition to describing unit actions that can be supported by effective use of digital systems (e.g., supporting unit transition from movement to maneuver), the team considered whether it is better to measure digital support of each action using an all-or-none approach or a graded approach. This latter consideration provides input for efforts to define digital proficiency levels.

15. SUBJECT TERMS

Digitization	Transformation	Digital Performance	Echelon Effects
Performance Assessment	Measures of Performance	First Digital Division	Future Combat Systems (FCS)

SECURITY CLASSIFICATION OF			19. LIMITATION OF ABSTRACT	20. NUMBER OF PAGES	21. RESPONSIBLE PERSON (Name and Telephone Number)
16. REPORT	17. ABSTRACT	18. THIS PAGE			
Unclassified	Unclassified	Unclassified	Unlimited	78	Dr. Larry Meliza (407) 384-3992

Research Report 1791

MEASURING DIGITAL PROFICIENCY: ASSESSMENT APPROACHES AND ECHELON CONSIDERATIONS

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June 2002

Army Project Number **Personnel Performance and**
2O262785A790 **Training Technology**

FOREWORD

The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) Simulator Systems Research Unit (SSRU) conducts research to investigate the training and performance assessment requirements of the future force. The SSRU supports the U.S. Army Training and Doctrine Command (TRADOC) and the U.S. Army Simulation, Training and Instrumentation Command (STRICOM) by defining current and future training requirements, developing performance measurement technology, and evaluating training concepts.

The research described in this report investigated key aspects of measuring performance in a digital combat unit, including echelon differences in warfighter tasks/skills and the nature of proficiency assessment needs. Based on an analysis by a panel of experts, review of Army documents, and interviews with digital warfighters, knowledge and performance differences were charted between brigade and battalion staff levels. Suitable measurement approaches for sub-tasks involved in two key combat tasks were then explored.

The investigation established a preliminary knowledge base for understanding the performance and assessment requirements of the future force. It created an initial foundation for developing realistic measures of digital skill proficiency capable of supporting successful digital operations.

This report is one of two reports documenting the methods and findings of the research project. The companion report addresses the behavioral and performance changes that occur in units transitioning to digital operations. The contractor briefed the results of this work at Fort Hood, TX on 15 June 2001. The audience included representatives of the III Corps Battle Command Training Center. ARI briefed the preliminary results at the Quarterly Army Battle Command System Integration Meeting, on 19 December 2001, held at the Applied Research Laboratory of the University of Texas. This meeting included representatives of the Army Battle Command System TRADOC Program Integration Office, the TRADOC Army Modernization Directorate, the U.S. Army's Joint Readiness Training Center, the U.S. Army's National Training Center, the STRICOM Project Manager for Digitized Training, and the STRICOM Project Manager for Training Devices.

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ACKNOWLEDGEMENTS

We thank the members of the 1st Brigade, 4th Infantry Division who generously participated in the interview sessions. The brigade's Commander, COL Oscar "Randy" Anderson, was especially supportive. We are grateful to COL (Ret) Darrel Charlton and LTG (Ret) Don Holder of TRW for invaluable input as subject matter experts and for assistance in reviewing and refining this report. Ms. Wilma Sanders, also of TRW, expertly supported editing and production of the report.

MEASURING DIGITAL PROFICIENCY: ASSESSMENT APPROACHES AND ECHELON CONSIDERATIONS

EXECUTIVE SUMMARY

Research Requirement:

The United States Army is engaged in a modernization campaign that relies heavily on digital technologies and will culminate in the Future Combat System (FCS). Digital warriors of today and tomorrow need training that enables full realization of the benefits of new digital systems. Such training requires specification of digital tasks and skills and tools for measuring proficiency. The U.S. Army needs measures of digital proficiency to examine the impacts of evolving digital systems and tactics, techniques and procedures (TTPs) on the ability of units to exploit digital technologies. Digital proficiency goes beyond the mere operation of digital systems to include using the information from digital systems in performing mission tasks. Digitization can add to collective trainer workloads by making it necessary to consider operator interactions with digital systems and interactions between operators and digital information users. It is crucial to focus measurement on activities that warrant the attention of trainers and to apply other strategies for reducing trainer workloads (e.g., tailoring measurement objectives to fit the likely digital proficiency levels). The first objective of this work was to identify aspects of digital proficiency likely to warrant the attention of trainers, and the second was to develop information for use in defining the concept of digital proficiency levels.

Procedure:

The research team compared battalion and brigade echelons in terms of how digital systems are employed and in terms of the knowledge and skills required in applying the systems. The team also described how a unit can use digital systems to reduce fratricides and gain greater control over how and when contact is made with the enemy, two of the major "advertised" benefits of digitization. The analysis of fratricide was organized according to the seven forms of contact and was enlarged to include instances that are not strictly fratricide prevention (e.g., making sure friendly units do not enter areas chemically contaminated by the enemy). The analysis regarding control of enemy contact variables was organized in terms of mission phases (plan, prepare and execute) and in terms of major subtasks, such as terrain analysis in fire support planning. The activities supporting fratricide reduction and control over contact variables were re-examined in an effort to decide whether an all-or-none or graded performance measurement approach (trained-needs practice-untrained) would be more appropriate.

The research team made use of expertise of the Army's First Digital Division (FDD), the prime repository of organizational experience regarding digital operations. The team interviewed leaders and soldiers from the 1st Brigade Combat Team of the 4th ID, and the team employed panels of experts composed of personnel with experience conducting or supporting digital training. The research team also reviewed reports on digital training experiences, and Army training documents. The training documents included tactics, techniques, and procedures (TTP) and mission training plans (MTPs) for digitized units, plus system operator guides and digital unit operating procedures.

Findings:

Many of the differences between digitized battalion and brigade echelons are due, in part, to the reductions in unit size made in anticipation of the benefits of digitization. Many battle operating system (BOS) integration functions have shifted from battalion or division level to brigade. Brigade staff operations require a higher level of digital skills, combined arms knowledge, and service experience stemming from several factors present at the brigade echelon—a balanced interest in planning and execution, specialized information responsibilities, and unique combat functions. In essence, the conditions and standards for performing digital tasks and skills vary somewhat between brigade and battalion echelons.

The team was able to identify many digital activities likely to warrant the attention of trainers in that they can help to reduce fratricides and/or help a unit gain greater control over enemy contact variables. For example, digital systems can help a unit make the transition from movement to maneuver in a variety of ways that include: using terrain analysis tools and digitally-provided information on enemy location to identify the Probable Line of Deployment (PLD); digitally sending overlays showing the PLD to higher headquarters and subordinate elements; ordering subordinate elements to change formation and movement techniques when digital situation awareness displays show the unit is approaching the PLD; and using digital situation displays to make sure orders for changing formations and movement techniques are being followed.

The team identified a number of digital activities likely to warrant measurement and the attention of trainers because they appear to be unique to brigade operations, help to reduce fratricides, and/or help a unit gain greater control over enemy contact variables. These activities do not represent an exhaustive list of all digital activities that, for example, help a unit gain greater control over enemy contact variables.

The team developed information with the potential to enable measurement of digital proficiency levels. While most of the activities contributing to fratricide reduction were considered appropriate for all or none assessments, many of the activities supporting control over contact variables were considered appropriate for graded measures of performance. Graded measures of performance can be important in defining proficiency levels. Finally, in looking across the various activities supporting fratricide reduction and helping to control contact variables, it is clear that certain digital activities tend to show up repeatedly across various analyses (e.g., the use of digital capabilities to predict where and when contact is likely to occur supports the transition from movement to maneuver and helps to consider terrain variables important in fire support planning and execution). Proficiencies in these supportive activities should be considered when developing digital proficiency level concepts.

Utilization of Findings:

The findings are providing input for an U.S. Army Armor School and Center effort to document TTPs for digitized units. Findings are being used as input for the program of instruction for digitized units within the III Corps Battle Command Training Center (BCTC) at Fort Hood, TX.

MEASURING DIGITAL PROFICIENCY: ASSESSMENT APPROACHES AND ECHELON CONSIDERATIONS

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MEASURING DIGITAL PROFICIENCY: ASSESSMENT APPROACHES AND ECHELON CONSIDERATIONS

INTRODUCTION

The U.S. Army Research Institute (ARI) has focused an investigative spotlight on the human dimensions of Army units transforming from conventional to digital operations. As part of this research, ARI's Simulator Systems Research Unit (SSRU) conducted the project entitled, *Measuring the Evolution of Unit Digitization and Digital Skills Proficiency* (MEDD). This project explored the behavioral and performance assessment dimensions of units learning to accomplish combat tasks using digital capabilities of the Army Battle Command System (ABCS). Three primary goals drove the research: (1) Describe changes in behavior of units as they digitize, along with the benefits and impacts of those changes; (2) determine if new digital skill requirements emerge at brigade level; and (3) explore the measurement of skill proficiency level and how it relates to unit performance. This report presents the methods and findings associated with the second and third goals. A companion report (Dudley, Johnston, Jones, Strauss, & Meliza, 2001) deals with the first goal.

Organization of the Report

The report targets U.S. Army training researchers, training developers, Combined Arms Training Strategy (CATS) proponents, and leaders of digital units beginning the transformation from conventional to digital operations. The report's information is valuable for development of digitally focused training programs at institutional, installation, and unit levels. Four chapters organize the contents:

- *Introduction*. Setting the context for the current effort, this chapter describes the background, briefly defines the problem, and outlines the project's technical objectives.
- *Method*. This chapter explains the sources of data, the data collection procedures, and the data reduction and analysis approaches.
- *Findings and Discussion.* This chapter discusses the findings related to potential differences between digital skills at brigade and battalion echelons, as well as performance assessment considerations for two key battlefield tasks.
- *Conclusions and Recommendations*. The final chapter distills the major themes and recommends follow-on research efforts.

Background

As part of a sweeping effort to meet defense challenges of the future, the Army is transitioning its fighting forces from traditional analog organizations to new digitized units equipped with platforms and command posts that leverage information age technologies (Shinseki, 2000). In the process the service is literally revolutionizing its combat force. Tactical units of the 21st century will rely increasingly on digital capabilities to acquire, exchange, and employ timely information throughout the battlespace (e.g., U.S. Department of the Army, 2001). Digital command, control, communications, computers, and intelligence (C4I)

technologies such as the ABCS promise substantially improved warfighting capabilities. Effective employment of advanced C4I systems is expected to produce faster decision cycles, greater agility of maneuver and fires, better precision targeting, and improved situational dominance on dispersed battlefields. Success in future military operations will depend heavily on confident leaders with consummate digital skills. Training for successful digital operations will require realistic performance measurement approaches geared to establishing and maintaining digital proficiency.

As digital systems are fielded across the force, soldiers and leaders are challenged to become proficient at operating and employing these new capabilities. Evolving tactics, techniques, and procedures (TTP), unit standing operating procedures (SOPs), and mission essential tasks are driving new performance requirements and standards. Digitally grounded tasks and skills for leaders and soldiers will come into increasingly sharper focus. Meaningful and accurate measures of performance will be crucial to ensure valid metrics of proficiency. Understanding the dynamics of digital performance and how it can be quantified across different tasks, echelons, and situations is a foundation requirement. Such understanding will generate critical building blocks for effective training programs as well as commanders' assessment tools. The resulting products will become critical enablers for units striving to achieve a winning edge through digital operations.

Based on observations of the Task Force XXI Advanced Warfighting Experiment (AWE), BDM Federal, Inc. (1997) described how warfighting activities of digitized units differ from those of analog units. The resulting "Do Differents" paved the way for a series of digital operator's guides, tactical SOPs, and digital doctrinal manuals for ABCS operators and staffs (TRW Inc., 1999, 2000a, 2000b). The digital procedures contained in these documents proved effective for utilizing current systems and established a start point for defining how units can exploit digital capabilities. The SOPs and manuals supported digital warfighters with preliminary how-to-fight descriptions for the emerging battlefield environment. The collection of techniques and procedures provides a foundation for identifying digital tasks and skills necessary for successful tactical operations.

Documentation of tasks and skills specifically linked to digital capabilities is a relatively new endeavor. Ford, Campbell, and Cobb (1998) analyzed task and skill requirements for the M1A2 tank, emphasizing individual performance. Sanders and Elliott (1996) identified tasks for the digitized battalion task force staff, focusing heavily on troop leading procedures. Barnett, Meliza, and McCluskey (2001) analyzed digital operator and leader skills, with an eye to developing high-priority measures of performance. The Warrior-T project, a training support activity of the Army Training Support Center, has recently completed an extensive review of tasks for the current ABCS systems. A key product is a combined listing, organized by staff section and battlefield operating system (BOS), of the various collective tasks required of Force XXI units today (Warrior-T, 2001). This listing provides a baseline of tasks for use by training proponents and researchers alike as the Army explores changes associated with digitization.

To date, only one division—the 4th Infantry Division (4ID)—has employed digital systems in multiple brigade combat teams (BCTs). As the vanguard of the Force XXI program, the 4ID's 1st and 2nd BCTs have each completed a digital rotation at the National Training Center

(NTC), with the latter spearheading the Division Capstone Exercise (DCX), Phase I. The Division, with BCT participation, recently completed the simulation-based DCX Phase II at Fort Hood. As the 4ID reaches maturity and stability in digital operations, it provides a repository of experience and insights regarding digital tasks, skills, and knowledge essential for soldiers and leaders. In the meantime, a second division has begun the transition process. The 1st Cavalry Division (1CD) is now transitioning the first of three brigades to new digital platforms and C4I systems.

An uncharted dimension of Force XXI transition relates to the progression of digital tasks and skills as a leader's career takes him/her from one echelon to the next. It seems axiomatic that the digital skills acquired as a platoon leader will apply throughout a leader's career. However, it also seems clear that those skills will not remain sufficient over time and that leaders will have to acquire additional digital skills as they graduate to higher levels of responsibility. It is likely that new skill requirements arise at higher echelons, especially when staff elements and functions enter the picture. If new skills are needed, what are they and when do they first appear? Even if essential digital skills do not change across echelons, how might performance conditions and standards change from one echelon to the next? Answers to these questions are important for developing effective training programs with meaningful measures of performance.

Performance assessment tools are as important in digital units as they are in conventional units. Assessment of skill proficiency levels enables leaders and trainers to identify shortfalls in unit performance and plan training programs accordingly. In the case of digitized units, proficiency assessments must consider how well leaders and soldiers use digital information as well as considering operation of digital systems (U.S. Army, 2000). Proficiency assessment tools also play a key role in determining when a unit is ready to proceed to a more challenging level of training. The most common performance measurement approach in the tactical environment involves all-or-none scoring of prescribed tasks. The training unit receives a "go" or "no go" for a specific task based on established performance standards. In the case of a "no go," the score says nothing about how close the unit came to meeting the standards—it could be close or far off. For many digital tasks pass-fail scoring may be fully satisfactory. However, some digital tasks might benefit from a scoring approach that provides graduated feedback on the level of proficiency. An example of graduated scoring is the Trained-Practice-Untrained (T-P-U) scale used in most Army training arenas. In terms of digital skills training, little is known about proficiency levels and how they relate to training effectiveness. A major exception to this statement is that we know that proficiency operating digital systems is of limited value if leaders lack tactical skills (U.S. Army Training and Doctrine Command, 1998).

Problem Definition

Information age warfare is inducing changes in unit performance requirements and in the expected warfighting environment. Tomorrow's digital warfighters need realistic training that enables them to exploit the benefits of advanced C4I systems during digital operations. Effective training requires specification of digital tasks and skills in doctrinal/training publications plus tools for measuring task/skill performance. But little solid information is available to support assessment of digital proficiency and development of high-payoff training programs. The impact

of evolving TTPs, SOPs, and mission essential tasks on training and assessment requirements is unknown. Relatively little is known about collective digital tasks and skills, especially for staff elements. Contemporary concepts of digital skill proficiency are yet to be developed, and practical requirements for assessing digital proficiency are undocumented. It is not known whether digital skills are common across echelons or perhaps characterized by unique aspects at different echelons. Likewise, investigators have yet to explore how performance conditions and standards may change in the digital environment. In a nutshell, much work lies ahead to establish the knowledge base needed by training developers who are supporting the future force.

There is little doubt that digitization has the potential to overwhelm trainers with observation requirements (Brown, Anderson, Begley and Meliza, 1999, Gerlock and Meliza, 1999, Meliza, 1999). In addition to observing the same events applicable to analog units, trainers for digitized units must attend to interactions between operators and digital systems, interactions between system operators and digital information users, and even interactions among system operators. One means of addressing this measurement problem is to identify the aspects of digital proficiency that most warrant the attention of trainers, due to their potential contributions to unit effectiveness. Another approach is to tailor observation requirements to fit unit digital proficiency levels.

As the Army's First Digital Division (FDD), the 4ID represents the primary repository of organizational experience regarding digital performance and assessment. The project described in this report was designed to document the insights of warfighters in the 4ID's digitization progress. A key goal was to document digital performance and assessment requirements, including potential differences between battalion and brigade echelons in terms of digital tasks and skills. The research team compared battalion and brigade activities to determine if new skill requirements emerge at brigade level. They also explored two key combat tasks to determine how unit performance relates to digital proficiency and how the latter should be measured.

Technical Objectives

The following technical objectives guided the MEDD research:

- Describe changes in the behavior of units as they gain experience using digital systems.
- Describe expected benefits of changes in the behavior of units associated with digitization.
- Describe changes in unit understanding of digital skills, the value and role of digitization, and the need for additional guidance regarding system operation or employment.
- Assess whether new digital skills emerge at brigade level.
- Examine the use of graduated versus all-or-none measures of digital skill/task proficiency.

This report addresses the last two technical objectives, which were the focus of the second phase of the project. The first three technical objectives are the subject of a companion report (Dudley, Johnston, Jones, Strauss, & Meliza, 2001).

METHOD

This phase of the MEDD project pursued two primary goals: (1) to determine whether a brigade staff needs digital skills not found at the battalion level, and (2) to analyze the digital proficiency assessment needs associated with representative combat tasks. The research team initially reviewed pertinent Army documents to discern what the current training literature said about echelon differences and performance assessment. Multiple interviews then were conducted with current and recently retired 4ID leaders in order to capture the essence of the division's digital experiences. A panel of retired experts then convened to apply their own insights and experiences with digital tasks/skills and performance assessment to expand the knowledge base.

Analysts proceeded by deliberate steps toward the goal of exploring digital skills proficiency assessment. The team identified high-priority combat tasks, based largely on their importance for combat success and their potential for being positively influenced by digital capabilities. Key factors in judging the potential extent of digital contributions included the advantages that C4I systems bring to the commander's visualization of the battlefield and situational understanding. Near the project's outset, the team targeted three high-priority tasks: (1) preventing fratricide; (2) controlling contact with the enemy; and (3) maintaining tactical adaptability. Following the collection of primary data, the team narrowed the set of tasks to the first two.

Data Collection Procedures

Review of Documents

The team conducted an extensive review of relevant literature and programs, all of which offered potentially valuable input to this effort. The selected literature (listed in Appendix B) dealt with Force XXI training requirements, conventional training doctrine, digital battle staff performance, and system operator guidelines. The research team's SMEs analyzed their assigned references, distilled digital tasks and skills, and synthesized ideas and common threads pertaining to digital skills proficiency. The resulting lists of common digital tasks and skills were combined with the interview findings to form a preliminary database.

Interviews

Interview participants. The research team interviewed the 1st BCT, 4ID leadership at Fort Hood during umbrella week (April 2-6, 2001). The participants included a brigade and a battalion Commander, Executive Officer, primary staff (S1, S2, S3, S4, S6), special staff (Fire Support Officer [FSO], Engineer, Air Defense Artillery [ADA] Officer, Analysis and Control Team [ACT] Chief), and selected maneuver company commanders, platoon leaders, and ABCS operators. In addition, the team interviewed four recently retired digital operations SMEs, all with command experience plus service with the 4ID, and a reserve officer formerly assigned to the 4ID. Finally, informal interviews were held with several retired senior non-commissioned officers (NCOs) having recent active duty experience in the 4ID.

Interview procedures. The interview team generally consisted of two SMEs serving as facilitators and one note-taker at each interview session. In order to structure the interviews, the facilitators used an interview guide containing general instructions and questions of interest (Appendix A). Most interviews were tape recorded for later transcription. Each session lasted approximately 2 hours, whether one-on-one or group interview.

The interview process probed for knowledge of digital tasks and their supporting digital skills, in a project-wide context addressing all technical objectives. Interviews were designed to capture objective, behavior-based evidence of unit transformation to digital operations and insights of leaders and soldiers. The intent was to garner a reflective view of digital transformation, gather data based on actual NTC experience, and identify specific digital tasks that merit further study.

Interviewees were instructed to answer questions using their areas of expertise as a reference point. For instance, the S2 answered questions relating to intelligence tasks and issues as they pertained to digital skills proficiency in the intelligence area. Similarly, company commanders spoke to specific tasks and issues relating to company and platoon level requirements.

A transcript of each 4ID interview session was prepared from the tape recordings, with the aid of notes taken during the session. Each transcript was reviewed and edited by the interview team to produce an accurate record. For the interviews with the retired SMEs, a thematic summary of each session was prepared.

Interview questions. Appendix A contains the interview questions which include items addressing both phases of the project. The queries targeted the unit's digital performance and training requirements with emphasis on high-value skills, abilities, and task proficiencies. For the purposes of this phase of the project, the questions of interest were those that focused on:

- Digital skills identified by unit leaders and soldiers, especially those that are independent of specific system software versions.
- Unit needs for better feedback on individual or collective progress.
- Potential emergence of new digital skills at brigade level.
- Practical needs regarding assessment of digital skills proficiency.

Panel of Experts

The document review and interview stages of data collection yielded disconnected bits of information about differentiating echelons and assessing proficiency in regards to digital skills. As a result, the team organized a panel of contractor personnel with expertise on digital operations and training. The panel of eight experts included field grade and general officers whose collective experience spanned multiple BOSs as well as command and staff assignments through brigade and division level. Each of the experts had either supported digitized units (e.g., by developing digital operator's guides) or served as a leader of a digitized unit. Three "brainstorming" sessions were organized to consider, in sequence, the following subjects: (1) proficiency concepts related to preventing fratricide; (2) proficiency concepts related to

controlling contact with the enemy; and (3) distinguishing digital skills between battalion and brigade echelons.

During each half-day session the panel discussed the questions of interest and the data gathered from the interviews and document reviews. Panel members articulated issues and considerations from their own perspective, and applied their own experiences and knowledge regarding digital task performance and assessment. A panel member (recorder) for each session took notes and subsequently prepared a thematic summary of the panel's deliberations and outcomes. The panel summaries substantially extended the database being assembled by the research team.

Data Reduction

The interview and document review data was organized into two distinct domains: (1) battalion versus brigade differences in tasks, skills, and knowledge, and (2) insights on preventing fratricide and controlling contact with the enemy. A lead SME combed through the accumulated interview transcripts plus the document-based notes to extract pertinent data elements and transfer them to an integrated file. The dual-domain compilation was then circulated for review by all the SMEs, with a focus on sufficiency of the assembled data.

The team's SMEs independently prepared battalion and brigade lists of digital tasks and skills, relying heavily on the data compiled from the document reviews. The independent lists were then consolidated by one SME. The integrating SME next refined the consolidated lists by incorporating tasks/skills from the Warrior-T battle staff task maps to create a master listing of common staff skills. These products were then reviewed by the various SMEs and revised as necessary. The resulting products were limited by the scarcity of specific digital tasks in the available documentation.

By consensus the team judged that the useful data gained from the interviews and Army documents was insufficient to meet the information needs of the phase's technical objectives. This led to the decision to convene the SME panel. The integrating SME shaped the data summaries resulting from the panel sessions to become the primary data compilations, into which the interview and document-based data were integrated.

Analytical Procedures

The compiled data contained qualitative information originating from training-related documents (see Appendix B), interview transcripts, and summaries of SME panel sessions. Separate but parallel procedures were used for analyzing and integrating the data related to (1) echelon differences in digital tasks/skills and (2) digital skill proficiency considerations. Given the qualitative nature of the data, strictly non-quantitative techniques were used for analysis.

Echelon Differences

The original plan called for comparing digital task lists for battalion and brigade echelons to determine differences in warfighter tasks and skills. Because of the lack of specific digital

tasks in the lists produced during data reduction, the team implemented an alternate approach. The lead SME reviewed the echelon-focused portion of the compiled data file, deriving implications for echelon differences in the process. He then presented resulting implications and conclusions to the SME panel for collective analysis. The panel discussed and weighed the findings, then considered the different knowledge requirements for battalion versus brigade staff members. The team members reviewed the resulting set of preliminary findings before finalizing them.

Digital Skill Proficiency Concepts

Working with the two expanded data summaries that resulted from data reduction, a lead SME sorted and organized the findings into a meaningful framework. The organization step was guided by the doctrinally recognized forms of contact (U.S. Department of the Army, 1996). The next analytical step entailed documenting the digital sub-tasks involved in preventing unwanted circumstances—either fratricide or unplanned enemy contact. Established doctrine generally drove this step, but the SME panel's knowledge and judgment played a key role where digitally anchored solutions were yet to be documented. The next step involved determining what measurement approach—go/no go or graduated—should be most suitable for a given task. In targeting a specific measurement approach, the team considered primarily the nature of the task, and secondarily the training needs of digital units. It should be noted that the team's determinations are preliminary and warrant additional study. In the final step, the SME panel members reviewed the complete analytical products and discussed differences of opinion until consensus was reached.

FINDINGS AND DISCUSSION

This chapter presents and discusses the specific findings that resulted from the warfighter interviews, document reviews, and expert panel deliberations. It is divided into the following major sections:

- Description of skill level and knowledge differences that separate battalion and brigade echelons
- Analysis of digital skill proficiency assessment for two key combat tasks:
  - Preventing fratricide
  - Controlling contact with the enemy

Echelon Differences

Literature Search Results

The literature search included draft Mission Training Plans (MTPs) for digital battalion and brigade operations, as well as work being done by TRADOC's Warrior-T organization at Fort Hood. The currently issued MTPs, which date back to the 1994-96 timeframe, were disregarded since they would obviously not have digital tasks. Instead, the review focused on the draft MTPs for digitized brigades and battalions (see Appendix B), which are nearly complete and should soon be ready for final approval and distribution.

The literature review results, from a perspective of seeking digital tasks and sub-tasks, were disappointing. Bluntly, the integration of digital aspects into the draft MTPs is virtually non-existent. The digitized brigade MTP includes the presence of ABCS in the "conditions" paragraph, but does not elaborate further in any of its tasks. The digitized battalion/task force MTP contains a task on establishing the Common Operating Picture (COP), but little else. Similarly, the Warrior-T work for the brigade staff focuses on individual task analysis with virtually no mention of digital systems or skills. Their work on brigade collective tasks does not achieve the level of detail of the draft battalion and brigade MTPs.

The greater level of detail in the draft MTPs is more encouraging. Both the Armor and Infantry Schools have expended a significant amount of effort to create documents with extensive detail, including task analysis. However, the documents do not specify digital tasks or sub-tasks. According to members of the doctrine directorates at both institutions, there are two main reasons for the absence of digital tasks and sub-tasks in the draft MTPs:

- The schools do not desire to have different MTPs for digital and analog units. This desire stems from the limited assets they have for doctrine development and the number of MTPs that have to be created for the force.
- The schools have explicitly adopted a generalized philosophical approach. If, for instance, the task is "To report," then the MTPs call for reporting via whatever tools are available and appropriate. They do not acknowledge a requirement to evaluate all the sub-tasks of an activity (e.g., operating a radio or sending a report using a digital system).

In summary, the soon to be released battalion and brigade MTPs contain great detail but few, if any, digital tasks or sub-tasks. It does not appear likely that this will change any time soon. Despite this absence of digital tasks in doctrinal publications, there is ample evidence that differences exist between brigade and battalion leaders in terms of their responsibilities and professional development. While fundamental tasks may not change, differences in conditions and standards for those tasks at brigade and battalion levels are emerging.

Echelonment of Skills

The differences in type and number of digital skills and tasks between battalion and brigade were deemed "minimal" by experts (both government and contractor). However, interviews and expert panel assessments emphasized skill level and "task-condition-standard" differences between these echelons. These differences are, in part, a result of emerging functional distinctions between the two headquarters in network centric operations, rearrangement of responsibilities that accompanies changes in force structure, and the inherent "digital maturity" of transforming units. Although this doesn't translate into requirements for many new digital skills at operator/leader level, the emerging notions of skill differences between brigade and battalion can now be identified with some clarity.

While tactical concepts, responsibilities, and dynamics differ between battalion and brigade, the staff operations and operator command and control (C2) tasks and skills at the two echelons are essentially the same. Speaking strictly in terms of digital operator skills for specific Army Tactical Command and Control Systems (ATCCS) and Force XXI Battle Command Brigade and Below (FBCB2), there is no difference in the skills required between battalion and brigade. The operators must have the same capabilities. The staff officers and NCOs at both echelons must have the same knowledge of how the systems function and interact. One need not serve first at battalion to be a proficient digital operator at brigade.

The battalions have four ATCCS systems: All Source Analysis System (ASAS), Advanced Field Artillery Tactical Data System (AFATDS), Maneuver Control System (MCS), and Combat Service Support Control System (CSSCS). [1]A Force XXI combat task force (battalion) will also have up to 140 FBCB2 platforms. These numbers and the powerful emerging focus on execution in network-centric operations highlight the battalion's concentration on FBCB2 platforms. Understanding the FBCB2 nuances, capabilities, maintenance, and connectivity is critical to the success of the maneuver battalion commander, his staff, and subordinates. Training first on the FBCB2 systems is paramount to success on the battlefield. Effective TTPs are essential for building, maintaining, and monitoring the network that supports FBCB2, the focus at the battalion level. Until ATCCS systems possess greater reliability, they will remain a lesser part of the battalion network effort.

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[1] This was the Basis of Issue Plan (BOIP) at the time this report was written. Per guidance from the Chief of Staff-Army, this basis of issue will change. A new BOIP has yet to be finalized/approved.

The brigade has a larger digital base and a broader field of digital concerns. The brigade headquarters will have, at most, 17 organic FBCB2 platforms, not counting those of its attachments and the Brigade Reconnaissance Troop (BRT). The brigade has all five ATCCS components—ASAS, AFATDS, MCS, CSSCS, and the Air and Missile Defense Work Station (AMDWS). It also has the Digital Topographic Support System (DTSS), the Battlefield Planning and Visualization (BPV) tool, and the White Board Video Teleconference (VTC) tool. Table 1 lists the systems and their quantities at the two echelons.

Table 1

Number of Digital Systems Present at Brigade and Battalion Echelons

System	Brigade	Battalion
FBCB2	17	140
ASAS	4	1
AFATDS	1	1
MCS	3	1
CSSCS	2	1
AMDWS	1	None
DTSS	1	None
BPV	1	None
White Board/VTC	1	None

These digital systems pass information via the tactical internet (TI). The TI is comprised of tactical radios, linked with routers using addressing and routing protocols that allow digital systems to send and receive location information and reports. The TI must deliver messages reliably despite mobility of units, loss of fighting systems and soldiers, obscuring terrain, enemy interference, destruction of command posts, loss of key elements and replacement of individual platforms. The TI consists of two primary segments—a lower TI operating at brigade level and below, and Warrior Information Network-Terrestrial (WIN-T, or upper TI) operating at brigade level and above. The linkage between the upper and lower TI and the integration of the unique systems is critical to the entire brigade's success in forming the COP. This effort is as complex as the battalion's task of synchronizing up to 140 FBCB2 operators.

At brigade level, the staff has to employ and integrate a greater variety of systems. For example, the brigade staff employs or receives information from Unmanned Aerial Vehicles (UAVs), the Joint Surveillance Target Attack Radar System (JSTARS), and divisional systems. That information is collated and fed down to the battalions.

The brigade staff's planning operations are also supplemented by the use of White Board VTCs with higher and adjacent units. These tools are not available at the battalion level in most cases. There is a knowledge and experience level associated with gaining the most from these systems, but it is not appreciably different from the basic knowledge that staff members at any echelon need to possess. The key difference at brigade level is the greater requirement to integrate the functions of diverse systems.

The volume of information and the number of information sources that support a brigade commander and staff are significantly greater than those of the battalions (with some exceptions). Brigade personnel must be more practiced and more capable in the basic staff coordination functions and processes. They must be masters of the military decision making process (MDMP) because so much of their energy and time is spent in planning. Table 2 captures one example of the emerging skill level and task condition differences between brigade and battalion.

The differences in skill level between the two echelons are related to several factors: focus of effort (planning vs. execution), information responsibilities (combat power generation vs. combat power management), and unique combat responsibilities. The battalion is becoming mainly execution-focused, while the brigade focuses increasingly on planning, integration, and synchronization. The battalion is simultaneously a provider and consumer of information (internally generated first, externally generated second), while the brigade is primarily a manager and consumer. Finally, certain key combat tasks have migrated from battalion to brigade echelon.

In the emerging network-centric framework, the battalion tends to focus more on execution and less on planning. The battalion is a capabilities-based organization that is becoming less involved in planning and more occupied with synchronizing near-term effects for decisive operations. In a sense, this represents a return to earlier practice (1940s to 1970s) whereby the Army regarded battalions as single function maneuver formations.

Table 2

Sample Brigade and Battalion Differences in Standards and Conditions

Task	Level	Standard	Conditions
Establish Common Operating Picture	Battalion	• 90% available broadcast across FBCB2 (lower TI) • 100% ATCCS connectivity within TF TOC, adjacent TFs, and Brigade	Given 3 companies, 140 FBCB2 platforms, 4 ATCCS systems, Tactical Internet Manager, and trained operators
	Brigade	• 90% broadcast across FBCB2 (lower TI) • 100% connectivity across ATCCS with subordinate battalion/TFs, adjacent brigades, division TAC/Main/Rear • 100% functionality of non-ATCCS systems, to include echelons above division systems	Given 3 combat, 2 combat support, and 1 combat service support FBCB2/ATCCS equipped battalions; 4 ATCCS systems and 4 special components; upper and lower TI; S6, and trained operators

The brigade, with its COP, rapid information sharing, and the proliferation of division and higher echelon information, bears a greater burden of setting conditions for the decisive, coordinated, fully supported operations of its battalions. Brigade responsibilities for detailed

planning, anticipatory reconnaissance and surveillance (R&S), integration of fires with maneuver, other shaping operations (mobility/countermobility, electronic warfare, air defense, NBC [nuclear, biological, and chemical] defense, and others), and logistics make its operations much more complicated than those of the battalions.

The responsibilities for maintaining the COP rest more heavily on the brigade's shoulders, but there is one immediate implication of concern to both battalion and brigade commanders—the importance of *network* Friendly Forces Information Requirements (FFIR). As part of their plan for battle command, commanders at both levels must understand network architecture and monitor information choke points, or weak links, to maintain network integrity and to assure their commanders' abilities to make timely decisions (see Table 3).

Force structure changes are key factors that affect the skill level and task-condition-standard differences between brigade and battalion levels. The Force XXI organization reduced combat battalions in size from four maneuver companies to three, cut the scout platoons from ten platforms to six, and reduced the mortar platoons from six tubes to four. These reductions were taken in anticipation of increased combat power effectiveness brought about by digitization. Arguably, this gain in combat power effectiveness is beginning to occur. Anecdotal evidence, collected during interviews with leaders of digitized units after an NTC rotation, indicates that three-company/team task forces perform to standard at NTC and that fire support and reconnaissance capabilities are as great as those of earlier organizations. From the brigade perspective, however, the loss of a quarter of its maneuver companies changes combat dynamics by making it harder to maintain reserves and by accelerating the rate of full commitment. ("Full commitment" means the loss of flexibility and acceptance of decisive combat that comes with employing all company-sized elements in decisive tactical actions.)

Table 3

Representative Friendly Forces Information Requirements

Sample FFIR	What/How to Observe	Alternatives	Failure
At least 4 of 7 TF position servers operational at all times	Monitor the broadcast of the 7 TF position servers via TIMS (snapshots every 2 hours)	Controlled substitution of FBCB2 or vehicle components	Loss of Co/Team or TF SA to Bde
Maintain 100% broadcast of 2 inter-brigade servers	Monitor the broadcast of S3 TOC server A and S4 ALOC server A every 2 hours via TIMS	Controlled substitution of FBCB2 or vehicle components	Gateway closed, no SA/C2 messages received or transmitted over EPLRS
MCS generated icons in Bde TOC	Maneuver Battle Captain check time of last MCS update, if greater than 15 minutes	Switch to FBCB2 feed	Loss of maneuver Situational Awareness/ Understanding

Certain operations now require greater brigade integration efforts. An example of "task migration" can be found in the task force obstacle breaching procedure. The doctrine for the mounted task force (U.S. Department of the Army, 1999a) states that the nominal task

organization for a breaching operation is composed of support, breach, and assault teams. This doctrine eliminates the former requirement for a reserve. To reduce tactical risk, the brigade must either task organize additional combat power to the three-team task force, or take on the execution responsibility of the breach. In either case, the brigade "owns" the preponderance of fire support assets and must shape the battlefield prior to this breaching operation. This is an example of the increased execution role of the brigade in Force XXI operations.

Another example is the "new" requirement for the brigade R&S plan. Brigade staff members must synchronize this plan in terms of resources, time, and space while maintaining the COP, providing analog backup, and reducing fratricide risks. In some digitized units the R&S plan is rehearsed with task force commanders at the brigade rock drill, prior to the maneuver rehearsal. Reducing fratricide risk is addressed in a later section.

The brigade then focuses intensively and extensively on integration and synchronization of the entire combined arms spectrum across all BOSs. Brigade commanders and their staffs must have an increased understanding of integration and the importance of synchronization. This should manifest itself in the planning effort, but does not obviate their execution responsibilities. Brigade personnel must not only identify the commander's critical information requirements (CCIR) but also use the information gleaned from situational understanding to facilitate planning, reallocate resources, and seize the execution advantages provided by enhanced battlefield visualization. The brigade staff must know how to set filters on their various systems, refine information into useable decision-making tools, and then understand how to display the information for the brigade and subordinate commanders. In short, the brigade staff must know how to leverage the information they receive. They must understand how to use the information to reduce risk and exploit the opportunities visualized on the battlefield. To accomplish these tasks, the individuals on brigade staffs must possess far broader experience than the typical battalion staff officer.

The final influence on digital skill level and task condition differences is "digital maturity." We are seeing the digital maturation of mid-grade leaders who have worked with MCS, AFATDS, and FBCB2, and have remained in the division for four years. These officers and NCOs now operate at a qualitatively higher level of digital understanding. These leaders can decisively influence tactical operations because of their past experiences. This increases the skill level of selected tasks, especially at brigade, by virtue of available expertise. The brigade Executive Officer (XO), S3, S2, and senior NCOs are often selected from subordinate battalion positions. In digital brigades, this means a brigade XO is a former task force S3/XO (trained in FBCB2 and MCS and familiar with ASAS and CSSCS). The brigade communications NCOIC (NCO In Charge) is a former task force communications NCOIC and trained in FBCB2, Tactical Internet Management System (TIMS), and connectivity centered on the tactical operations center (TOC). Obviously, a similar situation has existed in analog brigades, but that does not diminish the role of digital maturity as a key requirement for brigade staffs.

The tasks for the brigade have grown in number and importance with the evolution of digitization. Not only does the brigade staff have to operate and integrate multiple systems but they have also become the custodians of assets and responsibilities from both the division and

the subordinate battalions. Brief discussion of each follows to help build the understanding of the workload now prevalent among the digitized brigade staff.

Brigade versus Battalion: Special Responsibilities

Some specific tactical areas in which the brigades differ from the battalions are discussed in the following paragraphs.

Reconnaissance assets. Digitization and redistribution of scouts has forced much more concentration on the coordinated collection of information. The reconnaissance resources of the various subordinate maneuver elements are now managed by the brigade staff in its quest for situational awareness/understanding. The broad range of collection resources now under the brigade staff includes the reconnaissance platoons of the BRT, battalion scout platoons, Strikers (artillery-focused reconnaissance squads), ground surveillance radar assets, infantry patrols, JSTARS, UAV assets, and any other assets linked via the TI. These may even include the logistics package (LOGPAC) vehicles or a lone FBCB2-equipped fuel truck that sends Spot reports of enemy activity. The battalions formerly controlled all the scout elements within the brigade and typically conducted separate and independent reconnaissance and security operations. Today, all the scouts in the brigade work for the common good. On paper, battalion commanders still control their scout platoons, but because of the need for broader, overlapping, and coordinated coverage of larger areas of operation, coordination and synchronization of resources for the reconnaissance mission now occur at brigade level.

Analysis and Control Team (ACT). The division now allocates an ACT to each brigade to process intelligence information. The ACT plans and coordinates intelligence gathering plus it digests, refines, and disseminates information received from external sources like JSTARS and its Common Ground Station (CGS) module. The capacity to influence the electronic warfare plan is also uniquely resident in the brigade. This staff element is tightly integrated with the brigade S2 section that is integrating the Spot reports from various subordinate FBCB2 or ASAS reports into a COP of the battlefield.

Common Operating Picture (COP). At the battalion level the COP is provided primarily from the platform up. The battalions are providers as well as consumers of information. The battalion commander is interested in generating information for himself (knowing where his forces and the enemy are) to facilitate his mission execution, as well as to contribute to the brigade picture. Battalions require updates generally from subordinates to know what's happening in their area of operations (AO). The FBCB2 is the tool for that reporting. The battalion tactical information manager (TIM) is interested in keeping the net open between battalion and brigade headquarters. The status of battalion servers becomes a new, digitally related FFIR (see Table 3). With an operating lower TI, the battalion has access to the wealth of information available at the brigade level.

Maintaining the COP for the brigade is a much more complex task. The brigade has the responsibility to link the upper and lower TIs and add to the COP. Brigades focus on the sensor-to-shooter relationships throughout the AO, on the employment of shaping forces, and on tracking and directing the maneuver of their task forces. Numerous diverse systems must be

constantly connected and integrated. Maintenance of service links has become a critical task for the brigade TIM. The brigade TIM must manage both higher and lower levels of the communication architecture.

Bringing a TOC online is a time-consuming, intense, and precise process. Failure to do this properly can result in system crashes, loss of valuable time, and disruption of the entire brigade operation. The brigade staff soldier must not only receive and pass information but also must know what is important, what needs to be refined, what needs to be passed, and with whom the information needs to be shared. He must know the screen displays available at his level and at subordinate levels to quickly disseminate the COP and help the commanders retain battlefield visualization. He must have a basic understanding across all BOSs to successfully accomplish his job.

At battalion level, the corresponding process is normally a vertical exchange of information. The CSSCS operator passes logistics information to his next higher logistician who reacts and "plans" a response, if required. At brigade, information must simultaneously go in multiple directions. Integration and connectivity across systems have become an FFIR function at the brigade level. The ATCCS systems are the focus at brigade. These are key for synchronization and visualization by the commanders at all levels.

Obstacle Breaching. The conduct of the breaching operation exemplifies task migration to the brigade from the battalion. The Force XXI brigade has nine maneuver companies compared to its legacy counterpart's twelve companies. Battalions cannot now accomplish breach operations by themselves without additional resources. This requires the digital brigade to participate in the breaching operation to a greater extent than previously. The brigade must either plan and orchestrate the breach using resources from across the brigade or allocate added resources to individual battalion task forces so that they can accomplish the breaching by themselves. Both methods involve the brigade staff in obstacle breaching operations. Both solutions involve maneuver or engineer resources from across the brigade to successfully breach. Both methods require increased external synchronization to accomplish a collective task that used to be a task force battle drill. (Incidentally, this greater involvement in the details of tactical execution does *not* relieve the brigade staff from any of its responsibilities for facilitating the larger operations of its own forces or those of the division.)

Fratricide Risk. The risk for fratricide remains considerable in digital units. There are more resources in the AO that must be integrated in building and maintaining a COP. The BRT is one example. The previous need to follow the location of Colt Teams and dismounted infantry elements has now expanded to include Strikers, dismounted scouts, Sentinel radars, divisional military intelligence assets and forward arming and refueling points, and potentially a division reconnaissance element. Such forces may not be under the control of the leading battalion commander or the security force company commander. There is growing confidence in FBCB2 platforms to report the location of all Blue (friendly) forces. Leaders implement TTP to confirm the identification of "icons" in their AO. This effort is complicated by the proliferation of echelons above division (EAD) assets in the battalion and brigade AO. The relationship of those assets to the battalion, brigade, or even the division may be questionable at best. Are they attached, in direct support, or simply positioned in the AO? The best tactical positions tend to

draw many observers, some of them enemy. This drives the requirement for detailed, brigade level planning of R&S. The reporting and coordination procedures and processes between these strange battlefield bedfellows compound the potential for mistaken identity. As the digital transition progresses, it has become imperative that electronic identification of friendly assets be pursued and enhanced.

Air Defense. A final example lies in the ADA BOS. Currently, the AMDWS is not fielded to maneuver at battalion level. The ADA fight is one that occurs largely above the maneuver battalion's perspective. However, air tracks generated from AMDWS can now be portrayed on FBCB2. The brigade's ADA battery clearly does have different digital C2 tasks than its maneuver counterpart, as a result of equipment distribution, systems interfaces and doctrinal responsibilities.

Brigade-Battalion Differences by Position

The foregoing factors and others affect the functions of specific staff leaders. Another perspective for looking at the differences between brigade and battalion is the differing functions accomplished by the same staff position at brigade and battalion levels. Several comparisons follow.

Executive Officer. The brigade XO is clearly the "battle captain" for the brigade TOC, in that the brigade XO has responsibilities that are similar to those of a battle captain at battalion level. He has the responsibility for creating the COP across the brigade AO. This implies that he knows the ins and outs of his brigade TOC, the various BOSs, and the MDMP. It implies that he knows how to integrate staffs and is familiar with both subordinate and higher headquarters requirements and TTPs. It assumes that he is familiar with the various reports and screen displays on the various ATCCS systems in his TOC. The brigade XO is the "synchronization cornerstone" for the brigade. He has most likely been a battalion level S3 and probably served on a division staff in a digital unit. He is the key to digital management within the brigade.

The battalion XO does not have the same job focus or knowledge requirements that the brigade XO does. The battalion XO may not necessarily be a constant resident of the TOC. He might focus on combat power generation, maintenance, readiness, and the coordination of resources internally. This is probably his first job where he has had responsibility for a staff.

Battle Captain. The term "battle captain" is not defined in the primary doctrine on staff operations (U.S. Department of the Army, 1997). However, the term is widely used to describe the staff officer exercising C2 authority on behalf of the commander.

The commander must be able to visualize the battlefield and synchronize tasks and resources in order to accomplish the mission. The staff assists the commander in visualizing the battlefield, with the unit XO primarily responsible for synchronizing and integrating the staff's efforts. According to the Center for Army Lessons Learned (1995), the battle captain assists the XO in synchronizing and coordinating the staff's effort. The distinction between the two individuals lies in their levels of experience. During the battle, synchronizing and coordinating the staff is normally best served by the XO. During the preparation phase, the battle captain can

normally fulfill these duties. Experience at the Combat Training Centers (CTCs) shows that during the battle, the battle captain should focus his efforts on supervising the soldiers within the S3 operations cell rather than synchronizing the efforts of other staff members.

At brigade (U.S. Department of the Army, 1999b) the battle captain is the current operations information sharer for the unit. His emphasis is on transmission of information rather than integration or analysis. He is probably an Officer Advanced Course graduate who may or may not have commanded at the company level. He must be familiar with the FBCB2 displays and screens to accomplish his duties. He is usually a resourceful young officer selected for the position because of greater than average tactical competence.

At the battalion (U.S. Department of the Army, 1999a), this officer probably is a senior lieutenant who has not commanded and probably has only been to his Officer Basic Course. He is not BOS savvy beyond his own branch. His focus is more operational, on the current fight. His integration capabilities and requirements are minimal.

Personnel Officer (S1). There is no notable difference between brigade and battalion S1 tools, digital tasks, skills, functions, or knowledge requirements.

Intelligence Officer (S2). The brigade S2 section has far more information flowing into it than its battalion counterpart. The brigade S2 will have to process more reports, create more situational overlays and disseminate more information. The brigade S2 has the internal UAV, BRT, and ASAS responsibilities plus the external ACT, CGS, JSTARS, and divisional coordination requirements. Because of this, prior digital S2 experience is essential.

Plans and Operations Officer (S3). The battalion and brigade S3 have the same basic tasks. The brigade S3, however, has access to more information systems, employs more types of supporting units, and plans more complex and closely synchronized operations than his battalion counterpart does.

Logistics Officer (S4). There is no significant difference between brigade and battalion S4 tools, digital tasks, skills, functions, or knowledge requirements. However, brigade S4s must organize the support of a larger variety of units and anticipate requirements over a longer period.

Signal Officer (S6): The battalion and brigade S6 officers and sections both receive the same training and have the same skills requirements. However, only the brigade S6 can execute many of the tasks. Even though both are responsible for network management in the TOC, only the brigade S6 has the authority/capability to execute a Unit Task Organization (UTO), to set or change network passwords, and issue new internet protocol addresses. Executing a UTO change is the most critical task. Although the execution of a UTO change is not difficult, dealing with any problems arising out of the change may be challenging.

Fire Support Officer. The digital skills required by the brigade and battalion fire support officers are similar. They both must be experts in the capabilities and limitations of the artillery specific systems as well as how these systems interface and link with the other digital systems located in their respective TOCs. However, like other staff positions their duties and

responsibilities are quite different. Although they both play important roles in planning and execution, the brigade fire support officer's scope of responsibility goes well beyond those of the fire support officer at the battalion level.

The brigade plays a vital role in task force fire support planning and execution. With the exception of the battalion task force mortars, the brigade is the "provider of indirect fires." Therefore, any discussion of fire support planning and execution at the task force level must first start with the role of the brigade. The brigade develops a synchronized brigade scheme of maneuver and brigade concept of fires translating that concept into a scheme of fires—assigning fire support tasks and allocating assets and/or effects to subordinates. As part of that concept, it is the brigade's responsibility to set conditions for and provide indirect fires to the task force for the close/direct firefight. Fires in support of the task force close fight are provided for a specific period of time or a specific purpose. The brigade must clearly specify when fires will transition to the task force and when the task force will lose them. Refinements to the brigade scheme of fires from subordinate units must also be integrated. Finally, the brigade views the COP displayed in the TOC and integrates the movement of artillery units with the scheme of maneuver.

The battalion task force is the "executor" of their portion of the brigade scheme of fires. With the exception of the battalion mortars, the brigade commander controls all indirect fire assets supporting the brigade combat team. The artillery is normally in direct support (DS) of the brigade. Therefore, the battalion task force must clearly understand both the brigade concept of fires and how it is synchronized to support the brigade scheme of maneuver, and the task force's role in the execution of its portion of the brigade scheme of fires. Understanding this, the task force must develop its own concept fires. This concept normally involves assigned tasks from the brigade scheme of fires and targets to support the battalion task force close fight. Additionally, the task force must plan the synchronization of mortar fires with the scheme of maneuver, integrate the mortars into the scheme of fires, and synchronize their movement with the scheme of maneuver.

Engineer. Depending on how the Engineer Battalion orchestrates its workload, the engineers operating in the maneuver battalion command posts may have a greater digital workload than their counterparts at brigade. This is because the brigade may deal with obstacle planning and execution by defining the general belts for obstacles, then tracking progress of obstacle installation and engineer company employment. At the maneuver battalion level, the supporting engineers deal with the specifics of each obstacle based on terrain analysis, scheme of fires and maneuver, and the commander's intent. The engineers supporting the maneuver battalion and executing the obstacles are responsible for creating and updating the appropriate overlays and submitting digital obstacle reports.

Summary of Brigade versus Battalion Differences

To summarize, although there is not a substantial difference in the digital skills or training required to operate the ABCS systems between battalion and brigade echelons, there are differences in the digital maturity and knowledge required. There are also differences in the way

digital systems and information are used. Experience at battalion level is a prerequisite for some duties at brigade level in terms of digital skills. There is a difference in experiential knowledge required of the staffs at the different echelons. Generally, the brigade personnel need to be more mature both in their tactical backgrounds and in their digital knowledge.

From a leadership perspective, the battle command differences, as defined in doctrine (U.S. Department of the Army, 1999c), between brigade and battalion commanders are apparent in their visualization of the battlefield and in the overall complexity of their tasks. Battle command is the art of decision-making and leading on the battlefield. In order to accomplish this process, commanders must visualize the battlefield. Key to that visualization is the establishment of the COP. The differences in the methodology and systems used at these two echelons to achieve and maintain the COP, as well as the importance of those elements, are indicative of the unique conditions at the two levels.

Brigade staff officers are required to have a higher level of digital skills because the volume of digital information is much greater at the brigade level. Brigade staff officers are expected to filter information rapidly, which implies a capability to operate the digital platforms with dexterity and manipulate the data quickly into useable formats.

The results of our comparison of brigade and battalion roles and responsibilities for digitized units provides information that can be used to focus the attention of brigade trainers on activities unique to brigade. Although our effort has a measurement focus, there are implications for training as well (e.g., the Army needs to make sure that staff soldiers in the brigade TOC are aware of the screens available to other BOSs in the TOC). Major echelon differences that need to be considered when measuring how well brigades employ digital systems are listed below.

- Battalion and brigade have different conditions and standards for measuring how well digital connectivity is maintained.

- Brigade uses digital systems to develop and monitor the execution of reconnaissance and surveillance plans that encompass a wide variety of systems.

- While brigade engineers use digital systems to define general belts for obstacles, convey the location of the belts as overlays, and track the progress of obstacle installation and engineer company employment, battalion engineers use digital systems to create/update overlays for specific obstacles and submit digital obstacle reports.

- Brigade uses digital systems to integrate the movement of artillery units with the scheme of maneuver, while battalions synchronize the movement of their mortars with the scheme of maneuver.

- Brigade staff leaders are at the intersection of operations (current information) and plans (current information on out-of-contact enemy forces as well as projected enemy information) and must balance current operations with what will be required in the future.

- The brigade XO is the "battle captain" for the brigade TOC with responsibility for creating the COP across the brigade AO and acting as the synchronization cornerstone, while the battalion XO focuses on combat power generation, maintenance, readiness, and the coordination of resources internally.

- The brigade S6, but not battalion S6, has the authority and capability to execute a UTO, to set or change network passwords, and issue new internet protocol addresses.

- Brigades appear to be more involved in planning and synchronization than battalions, while maintaining the same level of concern with execution.

- Because of the greater synchronization role at brigade, the brigade staff soldier must:
  - know what is important, what needs to be passed, and with whom (in other BOSs) the information needs to be shared,
  - have a basic understanding of all BOSs,
  - and know the screen displays available at his/her level and at subordinate levels to quickly disseminate the COP.

- Brigade has the responsibility to link the upper and lower tactical internet, and the brigade tactical information manager must manage both the upper and lower net architecture.

- The capacity to influence the electronic warfare plan is uniquely resident in the brigade.

- The COP maintained by brigade should help it focus on sensor-to-shooter relationships throughout the AO, the employment of shaping forces, and tracking and directing task forces .

- The AMDWS is fielded at brigade and above, and the ADA fight is largely above the battalion's perspective.

- Brigade provides indirect fires, with the exception of mortars.

Digital Skill Proficiency Assessment: General Findings

In analyzing digital proficiency assessment needs, the team focused on determining what measurement approach—go/no go or graduated—should be suitable at the sub-task level. The expert panel concluded that existing measurement approaches are sufficient to quantify digital skill proficiency. The go/no go approach has stood the test of time and fits many digital sub-tasks. The established T-P-U (Trained-Practice-Untrained) scale is fully suitable when a graduated approach is needed. These recognized approaches offer simplicity and familiarity, which are important advantages in the everyday training environment. The team rejected more complicated approaches as unsuitable. Validation of these findings has yet to be addressed.

Three primary criteria emerged for selecting a suitable measurement approach: (1) the extent to which a sub-task is critical for mission success, (2) the relative complexity of a sub-task, and (3) the time span over which a sub-task is typically executed. A sub-task that is an absolute imperative for mission success is a strong candidate for go/no go scoring. When sub-tasks are quite complex or lengthy, graduated scoring should be considered. The graduated approach's recognition of a partial state of proficiency can be important as a means of avoiding total retraining.

As explained in the *Method* chapter, the team selected two high-priority combat tasks for analysis: prevention of fratricide and control of friendly forces contact with the enemy. The following sections discuss the sub-tasks involved for these two tasks and identify the preferred scoring approach (expert panel consensus). Specific scoring standards for each subtask were beyond the scope of this study and will require additional work.

Digital Skill Proficiency Assessment: Preventing Fratricide

Fratricide prevention is a complex subject that encompasses many tasks. Individual soldier training in tasks such as target identification (visual or thermal) is fundamental and singularly important. Leader and collective staff tasks in operational planning, execution, and risk assessment are also critical to avoiding or mitigating conditions that may lead to fratricide.

The team concentrated on identifying means of not only **preventing** fratricide, but also **reducing the risk** of fratricide. Fratricide is considered such a significant event that if it occurs in training, the individual/unit is under most standards given a "no go" or "untrained" rating no matter what actions were taken. However, the leaders and staff members may have appropriately taken a variety of positive actions to reduce the risk of fratricide. Evaluation of leaders and their unit's actions should be appropriately considered.

The use of digital tools can help avoid fratricide primarily by increasing the efficiency and accuracy of information dissemination and by increasing situational understanding at individual soldier and force levels. However, the majority of the actions that can be taken to prevent fratricide are based in training and application of techniques and procedures.

As a framework for addressing this complex subject, the team utilized the seven doctrinal forms of contact (U.S. Department of the Army, 1996):

- Visual
- Direct Fire
- Indirect Fire
- Electronic
- Obstacle
- Air
- NBC

This framework forms a logical approach for addressing the means to prevent fratricide in the practical contexts or forms in which it occurs.

Visual and Direct Fire Contact

There are five means of preventing fratricide for the visual and direct fire forms of contact:

Target identification. This is an individual task and includes the ability to identify targets through optics and thermal acquisition systems. Scoring: **Go/No Go**

Fire discipline. The utilization of proper fire discipline on combat vehicles is a means to ensure positive vehicle identification by the vehicle commander and gunner, and to ensure that the gunner is firing at the target the commander wants to engage. (This assumes the commander has identified properly that the target is not friendly.) Scoring: **Go/No Go**

Use of friendly identification systems. There are several methods and systems for friendly identification ranging from the high tech Battlefield Combat Identification System (BCIS) to the low tech approaches such as VS-17 panels (colored fabric panels). Other low-tech solutions include using reverse polarity tape, painted tactical markings, or colored lights on vehicles and challenge/password protocols for dismounted soldiers. Scoring: **Go/No Go**

Direct fire planning and control. The use of direct fire planning and control measures can reduce the potential for fratricide by orienting crews on the areas into which firing is permissible or restricted. The FBCB2 can assist by disseminating graphical control measures (boundaries, Restricted Fire Lines [RFL], No Fire Areas [NFA], and Terrain Index Reference System [TIRS] features). The digital sub-tasks associated with this are the creation, dissemination, and posting of an overlay.

With the far target location capability in FBCB2 equipped tanks (and the M1A2 tank), a ten-digit grid location can be obtained when the crew lases a target. A crew can lase a target and then look at the location on the FBCB2 screen to determine if it lies outside an area where fires would be restricted (e.g., across a boundary or beyond an RFL). Used in conjunction with the fire commands, these techniques reduce the potential for fratricide. This can be used for direct and indirect fires. To overcome the problem associated with the time required to create overlays in FBCB2, units have used TIRS for orienting fires. It should be noted that it is difficult to utilize these capabilities on the move or during rapidly changing situations. Still, the abilities far exceed what could be done in analog units. Scoring: **Graduated T, P, U**

Maintenance of FBCB2 situational awareness (SA). The availability of a relevant picture of the location of friendly forces and a platform's own position can significantly reduce the risk for fratricide. This SA is largely an automated process with FBCB2. However, there are many digital sub-tasks that must be properly performed by the operator to ensure that the SA picture is useful. These tasks include ensuring the system and related equipment (SINCGARS, EPLRS, GPS) are all functioning properly, setting filters, and, for leaders with dismounted soldiers on the ground, inputting a friendly Spot Report. Scoring: **Go/No Go**

There are no true collective staff tasks related to this particular area, since it entails individual soldier and crew actions. Staffs can assist by monitoring the positioning and

movement of elements using digital systems and providing alerts of potential fratricide conditions to units coming into close proximity to each other.

Indirect Fire Contact

Indirect fire is one of the largest causes of fratricide. While indirect fire and close air support operations are complex, there are several techniques and procedures that can be employed to reduce the potential for fratricide.

Fire support planning. The brigade will build the over-arching fire support plan in conjunction and synchronized with the maneuver and R&S plans. While there are several key elements of the plan, the proper use of fire support control measures (FSCMs), identification of observer positions, and planned targets are key elements which can be disseminated and updated during execution using digital systems, primarily AFATDS and FBCB2. Ensuring full dissemination to subordinate units, scouts, and mortar platoons is critical. Scoring: **Graduated T, P, U**

Maintenance of situational understanding. Digital systems can provide information to assist in positive clearance of fires. Key digital sub-tasks contribute to building the COP and making it relevant—setting system filters, maintaining network connectivity, ensuring systems are operational, and knowing what units might not be displayed. Assuring clear, complete understanding of analog unit locations throughout a brigade AO requires meticulous, repeated messaging and checking. Digitized staffs must have SOPs that assign responsibility for distributing analog unit information and confirming its understanding between staff elements and units. A particularly critical sub-task is using the Spot Report function in FBCB2 to create icons for dismounted elements. Scoring: **Graduated T, P, U**

Positive clearance of fires. Positive clearance of fires by commanders, observers, staffs, and fire direction elements is critical. Digital systems can aid in the process by showing both targets and friendly unit positions, but digital systems alone cannot be used for clearing fires for a variety of reasons (not all friendly elements are equipped with digital systems, not all systems are working, etc.). Digital systems can be used to deny fires, but not to clear fires. Scoring: **Go/No Go**

Use of AFATDS basic capabilities. After AFATDS determines that a target is suitable for attack, it will review the target for coordination requirements. It automatically checks each fire mission against established FSCMs and unit boundaries and notifies the operator of any violations. If violations occur, the AFATDS will automatically submit a digital request for coordination to the unit that established the measure. That unit must then either approve or deny the coordination request.

The AFATDS also considers operator-specified System Buffer Distances around FSCMs and unit zones. These weapon buffer distances (field artillery, mortar, air) ensure that the effects area for each weapon system does not violate the control or boundary/zone. The operator specified system buffer distances can be established by SOP or as part of the commander's

guidance based on the amount of risk he is willing to accept in executing fires in close proximity to friendly troops.

During the planning process, commanders should consider the fire support tasks that can be pre-cleared. Pre-cleared fires are specified tasks identified during the planning process. The commander can leverage the capabilities of digital systems to set the conditions required for the execution of a task without clearance confirmation at the time of execution. Some examples of conditions that a commander can set are:

- The fires do not violate any established maneuver control measure or FSCM.
- The observer calling for the fires must have positive identification of the target and it must meet the established engagement criteria.
- The observer calling fires on the target must meet established position location parameters to ensure accurate target location.
- The execution of and the digital links established for the mission must be planned and rehearsed prior to the operation.

Even with the enhanced SA offered by automated systems and the automated checks and warnings of AFATDS, there may still be instances where fires require voice coordination before clearance. Scoring: **Go/No Go**

Use of AFATDS intervention point settings. Another likely cause for indirect fire fratricides is fire mission processing time or responsiveness (the time it takes to process the fire mission and get rounds on target). In many cases by the time a fire mission can be processed and executed the maneuver situation has changed and friendly forces may have moved into the target area. The use of AFATDS Intervention Point (IP) settings provides a powerful capability to eliminate the traditional mission delays associated with processing fire missions through multiple layers of fire support coordination. Not every mission needs to pause at every fire support node in the mission thread. By tailoring AFATDS IPs, the commander can specify which missions pause for review (human intervention) at intermediate fire support nodes, and which missions automatically process through the fire support system to a firing unit for rapid response. This enables the commander to balance the needs for human control with fire mission responsiveness.

Ultimately, the use of AFATDs IPs is a matter of SOP. Determining when human intervention is needed and when to allow the computer process to run without intervention depends on the commander's confidence that the system will perform reliably, the current tactical situation, and the type and amount of fire support assets available to support the BCT's operation. Tailoring IPs may serve as an alternative to quick-fire channels and has the potential of offering near-real time sensor-to-shooter capabilities. Scoring: **Go/No Go**

Establishment and enforcement of safety zones. Safety zones are established that friendly units must not occupy relative to a target and given types of munitions. As part of the process for clearing fires, units must ensure that soldiers are not in these safety zones. A technique for doing this is to determine the largest possible effects radius of munitions to be used, and then to apply a template over each target to ensure that no soldiers are within that radius. Generally, two kilometers is an adequate radius, encompassing the effects of all artillery

and MLRS (Multiple Launch Rocket System) munitions. For close air support (CAS), the safety zone may have to be adjusted just prior to execution if the aircraft arrives with a different munition than expected. Digital tools can assist in this task through target overlays and the SA picture. However, staffs must remember that not all elements on the battlefield will be displayed in the SA picture. Also, how the filters are set on a system is critical. Scoring: **Go/No Go**

Control of non-broadcasting FBCB2 systems. A technique for reducing the risk of fratricide in digital units is to have platforms whose FBCB2 system is not functioning remain within 500 meters of a platform whose system is functioning. If a vehicle has to go outside the 500 meters limit or out of sight, its commander should ensure that the wingman knows his position via FM (frequency modulated) radio. This will help ensure that the non-functioning system is not entirely lost from the SA picture, gaining a measure of protection and visibility by its close proximity to a system that is generating an SA icon. Scoring: **Go/No Go**

Monitoring SA on co-hosted systems. Many of the digital systems are hosting two sets of software or have multiple functions. For example, staff fire support elements utilize AFATDS for tactical gunnery control, technical gunnery, and for monitoring the SA picture. Through the Joint Common Database, AFATDS has the capability of displaying the COP as well as the artillery/fire support specific situation. The AFATDS SA picture will also provide an accurate graphical portrayal of the battlespace using doctrinal battlefield geometries. It can portray individual friendly units (Blue), enemy units (Red), neutral units (Green), and range fans for radar, cannon, rocket, and mortar units. This information can be tailored to a number of separate overlays to enable the operator to view only specific information at any one time. The same capability exists in other staff elements and on many combat platforms such as Paladin and Linebacker. Procedures must be developed to ensure that the ability to monitor the COP is not lost by staff or leader elements while technical tasks are being performed on the digital system. Scoring: **Go/No Go**

Verification of target locations. The addition of new target acquisition capabilities on some systems, in particular the M1A2 and the M2A3, can provide highly accurate (ten digit) target locations. However, if not functioning properly, they can provide erroneous data that may cause fratricide. Two sub-tasks to evaluate are pre-combat checks on target location systems, and the continual checking of observer target location data by fire direction centers for validity and positive clearance of fires. Scoring: **Go/No Go**

Electronic Contact

Electronic contact does not directly cause fratricide, but can be a contributing factor. Some examples follow.

Protection against jamming of friendly systems. Electronic jamming operations that result in degradation or disruption of friendly communications can result in fratricide if it precludes communication between units or if it disrupts the COP. Scoring: **Go/No Go**

UAV target identification. Target identification is as important a skill for UAV operators as it is for soldiers firing direct fire weapons. Misidentification of targets by UAV operators may result in fratricide by indirect fires. Scoring: **Graduated T, P, U**

Validation of electronic targeting information. The increasing prevalence at lower echelons of electronic information on the enemy (fed by systems such as CGS) leads to frequent instances where indirect fires are prompted by electronic data. There is the possibility of fratricide occurring as friendly units become intermingled or acquired as part of the electronic picture. Positive clearance of fires procedures as well as close battle tracking and validation of the intelligence acquisitions can reduce the risk of fratricides. Scoring: **Graduated T, P, U**

Obstacle Contact

Obstacles, primarily minefields, have long been a major cause of direct fratricides that occur when friendly troops move into their neighbors' minefields and indirect fratricides that are caused when friendly obstacles prevent friendly forces from maneuvering to avoid the enemy. The likelihood of such events has increased with the fielding of systems like the Volcano, which can be emplaced quickly. Digital systems can make a substantial difference in disseminating obstacle information and providing obstacle warning to units, particularly those equipped with FBCB2.

Obstacle planning/execution. Brigade and battalion staffs plan and integrate obstacle operations with maneuver and fire support before and during operations. The operation plan, associated graphics, and the rehearsal of operations all help reduce the risks of obstacle fratricide. A detailed obstacle overlay that is widely disseminated, in advance and updated throughout the execution (construction) of the obstacles, is key to preventing fratricide. Additionally, the overlay must include enemy obstacles as they are discovered. Division and brigade level obstacle overlays (showing only obstacle zones and belts) do not significantly help in preventing fratricide, though they do assist in defining areas that must be kept free of obstacles to facilitate maneuver. The detailed obstacle overlays showing the exact location, orientation, dimensions, and nature of obstacles contribute the most to reducing obstacle fratricide risks. The most effective way of creating and disseminating the information is at company and battalion level, utilizing the FBCB2's Obstacle Overlay function and the geo-referenced Obstacle Report. That overlay can display obstacle planning and intent as well as known enemy obstacles and emplaced friendly obstacles. The benefit of utilizing the Obstacle Report is that it creates an icon for the obstacle that is disseminated network-wide and displayed on all FBCB2 systems. Additionally, FBCB2 will provide an audio and/or visual warning on the display when the platform comes within 500 meters of a reported obstacle. In brigades and battalions with analog supporting units, marked maps along with obstacle marking and guards remain important means of preventing fratricide. Scoring: **Graduated T, P, U**

Obstacle reporting and FBCB2 filter settings. There are also digital tasks at the platform level that relate to obstacles. Obstacle reports should be sent initially by voice followed by digital reports to generate a geo-referenced SA representation in the COP. Operators must be trained to set FBCB2 filters properly for geo-referenced messages. They can choose to hide or display all geo-referenced data from the filter dialog box. Operators equipped with CVC helmets

can also set their filters to turn on or off audible alert messages. If not turned on, they will not hear warnings that sound when they are dangerously close to a minefield. If the operator does not have his obstacle overlay posted, warnings and alerts will not be seen or heard. Scoring: **Graduated T, P, U**

Breach lane and bypass marking. Probably the most complex and challenging task in a direct firefight is to breach an obstacle covered by enemy fire. A critical aspect of that task is marking the breach lane (or a bypass lane) and disseminating the information to following elements. The FBCB2 can significantly assist by means of the Bridge report function that creates a geo-referenced icon for a lane location. Additionally, posting an FBCB2 equipped platform at the entrance to the lane or bypass and disseminating via FM the icon title of that vehicle will help units navigate to the lane location. The FBCB2 navigation and "steer-to" capabilities further aid in getting units to the lane entrance. The utilization of the FBCB2 capabilities does not remove the requirements for the traditional marking of lane entrance and exit points, lane marking, and posting of escorts. Scoring: **Graduated T, P, U**

Air Contact

This area addresses both the potential of fratricide from aircraft and against aircraft. Preventing aircraft fratricide is predominantly done through planning, using airspace control coordination measures and ground control measures, and monitoring the employment of friendly and enemy aircraft. Planning and coordination is similar to and integrated with the planning of indirect fires. Monitoring is conducted with the assistance of supporting aviation and air defense artillery elements and by air component liaison teams.

Army Airspace Command and Control (A2C2) measures. Air corridors and times are determined, synchronized, and rehearsed with the maneuver and fire plans to assist in preventing ground-to-air fratricide. Digital systems including MCS, AFATDS, AMDWS, and FBCB2 are all utilized for disseminating air corridor overlays. Scoring: **Graduated T, P, U**

Ground maneuver and fire support control measures. Standard ground force maneuver control measures (e.g., boundaries, limits of advance, phase lines, and objectives) and FSCMs (e.g., fire support coordination line, NFA, free fire areas, aviation attack boxes) are primary means of preventing air-to-ground fratricide. Disseminating these measures to Army and air component aircraft is essential to gaining protection from them. Scoring: **Graduated T, P, U**

Use of Identification Friend or Foe (IFF) systems. Existing IFF systems are significant factors in reducing fratricide of aircraft. Proper coordination and dissemination of system codes is critical. Scoring: **Go/No Go**

Training in aircraft recognition. Troop knowledge of friendly and enemy aircraft is basic to prevention of ground-to-air fratricide and affects prevention of air-to-ground fratricide (since aircraft are apt to return fire from any source). Assessing troop proficiency in aircraft recognition should be part of any evaluation of fratricide risk. Scoring: **Graduated T, P, U**

Weapons control discipline. Long-existing doctrine for weapons control status and air threat assists in reducing the potential for fratricide of aircraft. Scoring: **Go/No Go**

FM warning of friendly aircraft. An FM warning on unit nets and a change in weapons control status should precede ingress and egress of friendly aircraft. Scoring: **Go/No Go**

Target marking. Clearly defined target descriptions and target marking procedures contribute significantly to reducing fratricide by aircraft. Scoring: **Go/No Go**

Marking friendly positions and formations. Similarly, friendly positions and formations or vehicles may be marked as a means of reducing the risk of air-to-ground fratricide. Scoring: **Graduated T, P, U**

NBC Contact

NBC contact is a critical form of contact that can result in friendly casualties. Whether casualties from failure to disseminate information about NBC hazards are classified as fratricide or not is academic. Distributing that information is a critical aspect of preventing casualties.

Planning. Planning considers likely areas for enemy NBC attacks, establishes ways/means to monitor those areas, and identifies resources and locations for decontamination and medical support. Digital systems, particularly MCS and FBCB2, are utilized to transmit written and graphic information, including areas to monitor and location of support sites. Scoring: **Graduated T, P, U**

Hazardous area determination. When NBC attacks occur, the hazardous areas are appropriately reconnoitered to determine the type of hazard and the area contaminated. The results are reported and overlay information is created and disseminated via FM, MCS, and/or FBCB2. The FBCB2 also provides the capability to report hazardous areas created directly by enemy or friendly action or by incidental hazards created by combat (e.g., destruction of enemy ammunition by friendly artillery or inadvertent release of caustic chemicals from civilian storage facilities). Such reporting is accomplished via the NBC1 combat message. In the FBCB2 system the NBC1 report function creates an icon for the hazardous area that is disseminated network wide and displayed on all FBCB2 screens. Additionally, FBCB2 will provide an audio and/or visual warning when the platform comes within 500 meters of a reported chemical or biological hazard area and 1000 meters of a nuclear hazard area. Scoring: **Go/No Go**

Downwind message creation. For contamination that can be further spread by wind or water, a Downwind Hazard Message with overlay is created and disseminated via FM, MCS and/or FBCB2. Scoring: **Go/No Go**

Hazardous area marking. The limits of a contaminated area are physically marked to reduce the risk of platforms and personnel entering them. Scoring: **Go/No Go**

Summary of Findings for Preventing Fratricide

For the various doctrinal forms of contact with the enemy, preventing fratricide involves a few sub-tasks that revolve around digital tools and many sub-tasks that benefit directly from digital capabilities. Table 4 lists the sub-tasks for preventing fratricide. In the majority of the cases the recommended scoring approach is go/no go—reflecting mainly the critical importance of the various sub-tasks.

Table 4

Measurement Framework for Fratricide Prevention

Form of Contact	Sub-Task	Scoring
Visual &Direct Fire	Target identification	Go/no go
	Fire discipline	Go/no go
	Use of friendly identification systems	Go/no go
	Direct fire planning and control	Graduated
	Maintaining situational awareness (FBCB2)	Go/no go
Indirect Fire	Fire support planning	Graduated
	Maintaining situational understanding	Graduated
	Positive clearance of fires	Go/no go
	Use of AFATDS basic capabilities	Go/no go
	Use of AFATDS intervention point settings	Go/no go
	Establishing and enforcing safety zones	Go/no go
	Control of non-broadcasting FBCB2 systems	Go/no go
	SA monitoring on co-hosted systems	Go/no go
	Verification of target locations	Go/no go
Electronic	Protection against jamming of friendly systems	Go/no go
	UAV target identification	Graduated
	Validation of electronic targeting information	Graduated
Obstacle	Obstacle planning and execution	Graduated
	Use of FBCB2 for reporting and warnings	Graduated
	Marking breach and bypass lanes	Graduated
Air	Airspace command and control procedures	Graduated
	Use of maneuver/fire support control measures	Graduated
	Use of Identification Friend or Foe systems	Go/no go
	Training in aircraft recognition	Graduated
	Weapons control discipline	Go/no go
	FM warning of friendly aircraft ingress/egress	Go/no go
	Marking targets for aircraft	Go/no go
	Marking friendly positions and formations	Graduated
NBC	NBC planning	Graduated
	Hazardous area determination	Go/no go
	Downwind hazard message procedures	Go/no go
	Marking hazardous areas	Go/no go

Digital Skill Proficiency Assessment: Controlling Friendly Contact with the Enemy

Controlling contact with the enemy requires the utmost coordination, integration, and synchronization by commanders and staffs. It is the equivalent of "rocket science" in the business of warfighting. It requires a host of actions across multiple echelons and BOSs, cutting to the heart of combat operations. Maneuver companies and battalions cover the uncertain ground that leads to direct contact with the enemy. When both friendly and enemy elements are moving or when a defending enemy is using concealment, deception, and local security forces, intelligence from staff estimates or standoff systems will not pinpoint the enemy for the friendly commanders who make first contact. These commanders may have the help of air or ground scouts who can give them final reports on exact enemy dispositions, but controlling initial contact and maintaining it afterward remains difficult.

This report can only sample the scope of the actions required to control friendly contact with the enemy, describing some of the numerous actions involved and explaining the digital tasks, skills, and knowledge that are applicable. Further, discussing every doctrinal form of contact would be overwhelming. Accordingly, the term "contact" will generally apply to all forms of contact unless otherwise specified. In short, the findings related to control of contact with the enemy merely spotlight the tip of the iceberg.

This section focuses on setting the conditions under which friendly forces contact the enemy. Because discussing the actions required at every echelon is beyond the scope of this report, the presentation emphasizes the brigade, given its predominant role in controlling contact with the enemy. However, it should be noted that it is the company/team/troop/battery level of command where the forms of contact are orchestrated and managed.

Maneuver brigades (and battalions) set the conditions for companies to engage the enemy by seeing and understanding the enemy force, suppressing his fire, limiting his maneuver, and directing friendly company level units to advantageous positions in time to take advantage of specific vulnerabilities. Initial contact by committed companies generally fixes key elements of the enemy force while subsequent contact forces full commitment of the enemy under conditions that threaten his survival.

Key Terms and Concepts

Several concepts associated with controlling contact with the enemy merit definition. They will be used to highlight the utility and integration of digital C4I systems later in this section. The concepts are:

Situational understanding: the condition of knowing the position, strength and direction of movement of both enemy and friendly forces *and* understanding the combat power and options available to both combatants. Situational understanding should be considered a transient state that fluctuates in quality during combat because of casualties and changes in the enemy's dispositions and strength. Late detection of the movement of an enemy reserve, for instance, represents a temporary lapse in situational understanding that affects controlling the situation.

Time: the timing of first contact and the sequencing of the contact, which should be chosen by the commander of the formation that initiates contact. That unit may be either a battalion or a company sized unit, depending on terrain and formation. Mission constraints—movements directed by a higher level commander or requirements to make contact at a specific time or as soon as possible—may affect the local commander's freedom of action where time is concerned.

Location: the terrain aspects defining physical relationships between forces; the terrain on which contact initially occurs should afford the friendly element an advantage (cover and concealment, line of sight, etc.) over the enemy.

Formation: the tactical dispositions that affect speed, maneuverability, and delivery of direct fires affect the terms of initial contact and the commander's overall ability to maintain contact. Speed and maneuverability are major considerations in making contact on advantageous terms. The formations that maximize speed and maneuverability, however, rarely permit optimal employment of direct fire weapons and may increase the vulnerability of the friendly force to enemy action. Maneuvering commanders must, therefore, alter their dispositions skillfully to achieve all the advantages of speed, maneuver, and massed direct fires.

Action: the weapon system tasks that will place the enemy in danger of destruction, in a specific performance timeframe.

Freedom of action: the ability to maneuver and adjust dispositions. As long as the friendly force retains freedom of action it can maneuver to maintain contact and shape the terms of battle. Once all available forces are in the fight, freedom of action is limited to actions in contact with the enemy and future freedom of action depends on the outcome of the action. As long as the enemy maintains his own freedom of action, he can evade contact or break it. Retaining reserves, using delaying tactics and impeding the opponent's maneuver with obstacles are principal means of protecting freedom of action.

Framework for Discussion

The discussion in this section will rely on the doctrinal framework for conducting combat missions: planning, preparation, and execution. The digital enhancers involved at the brigade, battalion, and company levels during each phase of planning, preparation, and execution will be addressed. The parallel processes that are performed at each echelon will be examined, along with how friendly forces' digital capabilities expedite those processes.

Figure 1 graphically depicts the continuous nature of operations. It portrays the brigade planning, preparing, and executing sequential missions. It shows the battalions and companies receiving input from echelons above brigade (EAB), such as plans from higher headquarters and JSTARS feeds, and then planning, preparing, and executing. At the bottom of the chart the activities inherent in the first mission—setting conditions, shaping the battlefield, and decisive operations—are indicated where (in general) they will occur during the operation. All of these activities take place simultaneously and in parallel. It is a maze of activity that is greatly facilitated by digital capabilities.

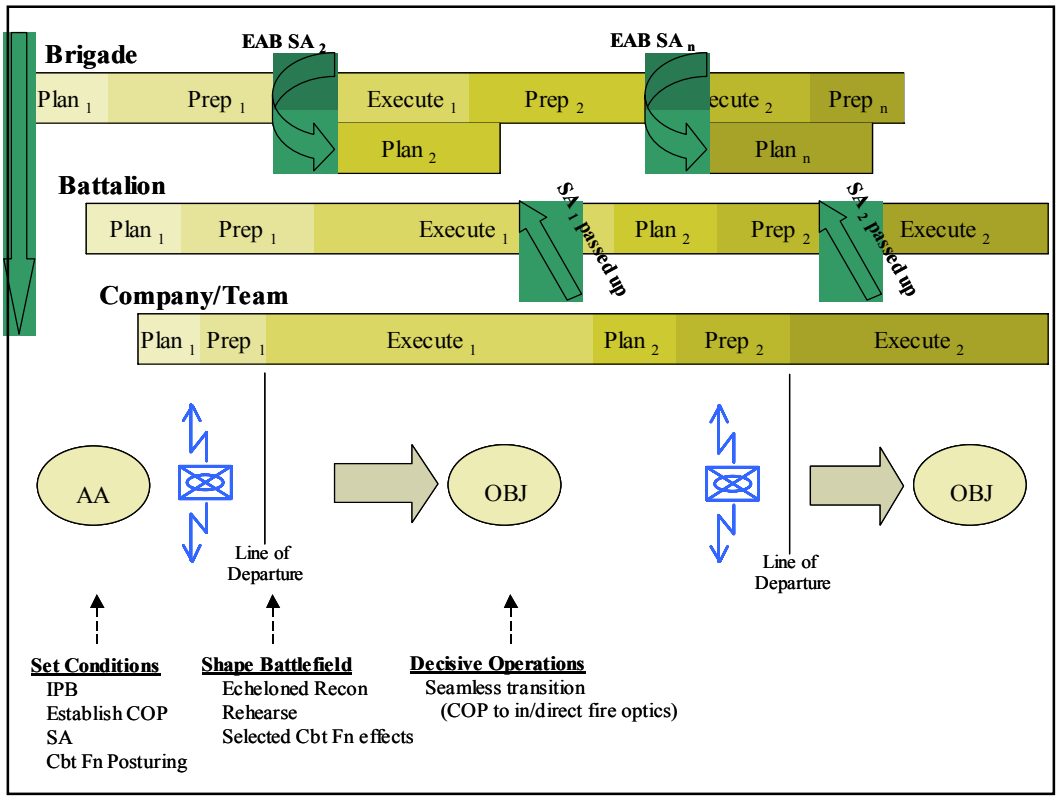

Figure 1. The continuous nature of operations.

Setting conditions occurs more or less constantly in brigades. Positioning units for future action, accomplishing assembly area activities, maneuvering to create advantageous battlefield geometry, distributing ammunition and other critical supplies, and marshalling combat support and combat service support all help set conditions. Some of this is done prior to crossing the line of departure in attack or before the security force fight in defense. Some setting of conditions (mostly adjustments to circumstances) occurs after combat commences and more is known about the enemy. It depends on the initial intelligence preparation of the battlefield (IPB) and on maintaining the COP, both of which are more precise and complete with digital capabilities.

Shaping the battlefield also begins before the main body crosses the line of departure and continues through decisive operations. It includes conducting echeloned reconnaissance, fighting to secure positional advantage and to destroy key elements of the enemy force, maneuvering to force enemy withdrawal from key terrain, interdicting enemy movement with deep fires and dynamic minefields, collecting critical information, and attacking enemy battle command. Even pre-combat tasks such as rehearsing the actions of reserves, re-arming, refueling and restoring inoperative equipment for committed units helps shape the battlefield. The essence of shaping the battlefield, however, is isolating and weakening targeted enemy units or positions while massing friendly combat potential to gain advantages in the decisive operation.

Decisive operations lead to the destruction of the enemy. In brigades they may occur in simultaneous engagements involving the entire brigade or in a series of smaller engagements in

which the brigade or its battalions destroy the enemy in detail. Controlling how friendly contact with the enemy is made and maintained may determine the outcome, duration, and casualties suffered in decisive operations. The quality of the transition from digital C4I system observation to weapon system (tank, IFV, M-16, etc.) optic acquisition of the enemy is critical. If the transition is seamless (from the viewpoint of the company and below) decisive operations begin under the best terms possible. If digitized direct fire companies see the enemy they expected in the terrain compartment indicated and know the general location of nearby enemy forces that can affect the engagement, the transition can be judged successful.

Current digital C4I systems allow the commander and staff to continuously "see" friendly units, the terrain, and significant parts of the enemy force. This information forms the basis of the Commander's Estimate. This estimate is the continuous assessment by the commander (supported by his staff's estimates) of the situation and how to employ forces. Therefore, the lines between planning, preparation, and execution and between setting conditions and shaping the battlefield are blurred within this doctrinal framework. The lines are also blurred between echelons as different levels of command perform their battlefield functions. Figure 1 depicts this continuous process and highlights some of the more important planning tasks that affect controlling friendly contact with the enemy.

Digital C4I systems allow the blending of stages/phases/operations with far less guesswork and stress on the part of commanders and staffs. They also enable greater efficiency, speed and precision in transition between setting conditions, shaping the battlefield and commencing decisive operations. All of this amounts to a significant tactical advantage over an enemy whose responses will be less certain and less rapid.

Once physical contact with the enemy is established and contact in its various forms is maintained, the ability to keep current operations information and projected operations information separate and distinct is of great value (see U.S. Department of the Army, 1999b, Chapter 3 for digital C2 techniques). The brigade staff leaders, such as the S3 and S2, are at the intersection of operations (current information) and plans (current information on out-of-contact enemy forces as well as projected enemy information). They must balance current operations with what will be required in the future.

General Activities

The continuous, overlapping process of planning, preparing, and executing missions is directly related to the ability to receive, digest, disseminate, and apply information. The digital tools at the brigade level assist in creating the COP, providing leaders and soldiers the ability to make critical decisions at a much faster pace. Across the plan-prepare-execute framework recurring tasks form the cornerstone of success. Without question, these tasks are iterated within each phase of the framework.

Maintain digital connectivity. This task is performed at all levels that have digital C4I systems. Operators must be able to power-up, troubleshoot their system(s), determine if a linkage to other system(s) has been established, and validate that information is flowing properly. This general task is performed by Abrams/Bradley commanders, Forward Observers,

individual ATCCS operators, TOC battle captains/NCOICs, and FBCB2-equipped commanders. Each unit SOP should specify the procedures for ensuring that digital information continues to flow properly throughout all phases of the mission. Insight into the standard for this task can be gained from Table 2.

As part of staging/assembly area procedures, units power up digital C4I systems and establish connectivity. This task can occur before or during planning or preparation or after task organization link-up. In either case, the task is critical. Each unit and command post (CP) must power up, test certain message functions, view out-of-unit friendly SA (i.e., determine that out-of-unit links are in place), and link to intra-, inter-, and subordinate TOC ATCCS. A recommended procedure is to run a mini-connectivity "exercise" at battalion level (to include the CPs) and report the status of FBCB2 and ATCCS connectivity to the brigade. One battalion commander's standard was to achieve 90 percent FBCB2 operational rate, receive SA from outside the battalion on FBCB2, link the TOC's ATCCS systems and ensure they are sharing information, send and receive information between FBCB2 and ATCCS (MCS, ASAS, AFATDS, and CSSCS, plus AMDWS at the brigade level), and link specific ATCCS systems to adjacent and higher echelons (e.g., MCS from 1-22 IN to 3-66 AR and to the brigade).

The battalion and brigade battle captains, as well as BOS managers, must routinely check their respective C4I systems to ensure timely information updates. If updates do not occur or if connectivity is lost within a particular BOS function, "analog safety nets" must be employed while connectivity is reestablished. Scoring: **Graduated T, P, U**

Establish and maintain the COP. Ensuring that commanders/leaders are looking at the same picture and have a common understanding is critical to battle command. The ability to share the same visualization of the battlefield allows for better risk assessments and timelier, better coordinated decisions. However, performing this task to standard requires completing a myriad of sub-tasks. Filter settings on FBCB2 must be correctly set and checked (see TRW Inc., 2000a for recommended Own Platform and Friendly SA filter settings). Intra-TOC and inter-TOC connectivity must be established and maintained. Data sharing must be validated and periodically checked. Battle staffs must routinely check for information updates. In other words, they must have SA of their own systems and know how to maintain system stability. Scoring: **Graduated T, P, U**

Military Decision Making Process (MDMP). The MDMP is performed basically the same way at battalion and higher levels. Commanders and staffs may abbreviate the process depending on the maturity of the staff, the available time and the involvement of the commander. The MDMP can be executed sequentially by echelon (consumes more time) or in parallel (preferred method). Digital tools expedite the MDMP and allow for all echelons to plan, prepare, and execute more effectively. Doctrinally, the division is planning 72 hours out for future operations, while brigades look out 48 to 60 hours. With the information that digital tools provide, brigade staffs can more effectively conduct continuous planning further out in time. The effects of digitization on specific limits for planning remain to be decided.

While the brigade and battalion commanders are concerned with the synchronization of separately controlled elements of combat power, the company commander is concerned with

planning and controlling maneuver, direct fire, and supporting (indirect) fire for his own unit. Where field grade commanders plan using their staffs and the MDMP, company/team level commanders use the simpler troop leading procedures (see U.S. Department of the Army, 1998, Chapter 2) in planning and preparing for operations. The company level plan must be flexible enough to account for a changed position in the task force formation or defense, changed enemy array, and changed time, yet still yield the same battlefield results. Company commanders therefore tend to focus on preparation and execution—actions on contact and actions on the objective. Scoring: **Graduated T, P, U**

Planning Phase

During the planning phase the friendly force will begin to set the conditions that will enable it to control contact with the enemy. The ABCS enhances planning by expediting the traditional method for preparing and distributing operation orders, plans, and overlays. For example, complete orders can be transmitted directly (instead of using a courier) to every echelon/platform that has FBCB2. With the Operator Response capability in FBCB2 messaging, leaders are assured the receipt of the order. (This feature requires that the operator respond to the critical message before another FBCB2 action can be accomplished.) At every echelon FBCB2 operators can post the operational graphics and envision the commander's intent with each sector clearly marked, while viewing a real time picture of the friendly forces. They can also view the reported Red picture in relation to the array of Blue forces, facilitating situational understanding down to the platform level.

The following activities must occur during the planning phase.

Intelligence preparation of the battlefield. Controlling contact requires detailed intelligence on enemy dispositions, combat systems, fire support, obstacles, security, and battle command. In planning, the commander oversees an IPB effort to determine these factors and other relevant information about the area of operations.

The IPB process is continuous. The brigade receives intelligence from EAB via digital communications. These feeds build the foundation for the brigade's planning. Some of the intelligence gathering tools at EAB are air scouts, HUMINT (human intelligence) collected at national levels, satellite imagery, JSTARS, and Quickfix (a heliborne electronic warfare system).. The brigade staff utilizes MCS, AFATDS, ASAS, and the UAV workstation to evaluate, correlate, and disseminate the information to subordinate units via the lower TI.

As the brigade is receiving information from EAB, it is simultaneously receiving data and information from its subordinate units via the lower TI. The primary tool to receive and pass information at battalion echelon and below is FBCB2. It can pass Red SA (Spot reports, Contact reports), Blue SA (individual platform icons), geo-referenced icons (NBC contaminated areas, enemy and friendly obstacle icons, logistical point icons) and operational graphics. Analysis of the bottom-up information by battalion and brigade S2s (especially by the ACT) and the integration of this information with the top-down information form the mainstay of creating a common enemy picture. Scoring: **Graduated T, P, U**

Terrain analysis. Terrain analysis provides the brigade and its subordinate units critical information for setting conditions to control friendly force contact with the enemy. This typically includes information on avenues of approach; cross-country and on-road trafficability; terrain effects on observation, cover, and concealment; natural obstacles; and inter-visibility factors.

The digital tools most commonly used for this purpose are DTSS (brigade level), Terra-Base (battalion-level) and FBCB2 (company and below). The DTSS and Terra-Base systems provide information on slope and soil conditions, route analysis, and inter-visibility. The DTSS will soon be linked with ATCCS.

A similar capability exists in the FBCB2's navigational tool and line of sight (LOS) tool. The navigational tool provides route information. The LOS tool supports direct fire planning by depicting dead space from specific points. It can also show weapons effects range fans so that leaders can ensure interlocking fields of fire. Units can now build a consolidated fire plan from each platform up through company level by using the range card overlay in FBCB2. Each vehicle builds a range card overlay that can be consolidated at platoon level. The platoon overlays can then be forwarded and consolidated at company level. This is much quicker and more accurate than the analog counterpart.

The role of terrain analysis in specific planning activities is discussed in the following paragraphs.

Terrain analysis in IPB. The terrain analysis information from FBCB2, Terra-Base, and DTSS, in conjunction with longer-range communications, contributes to the IPB process. They give the brigade new means of avoiding enemy fires and obstacles. Using the intelligence estimate in combination with the terrain information provides friendly commanders with two distinct advantages in controlling contact with that enemy. First, these tools allow the commander to disperse and position his forces across the AO so that they are more difficult for the enemy to locate and hit. Second, these terrain analysis tools provide the commander with a better understanding of friendly and enemy movement (time-distance) factors. They provide the commander insights concerning which routes to use, which routes to avoid, and when to start repositioning forces in order to bring overwhelming combat power against the enemy at the time and place of his choosing. Scoring: **Graduated T, P, U**

Terrain analysis in fire support planning. Digital terrain analysis tools are critical in fire support planning. When combined with AFATDS, Forward Observer System (FOS), FBCB2, and counter mortar/counter battery radars, the commander can use the digital tools to determine where to position his assets in order to take maximum advantage of their capabilities while at the same time reducing their vulnerabilities. The terrain analysis tools help the fire support planners identify screening crest, soil conditions, slope (which affects the cant of the weapon systems), and range fans for the various charges and projectiles available. Scoring: **Graduated T, P, U**

Terrain analysis in maneuver planning. The terrain analysis tools play an important role in identifying maneuver corridors and evaluating them in terms of speed, maneuver space, and cover and concealment. They also help in determining relational advantages of terrain positions

and in deciding when and where to engage the enemy with direct fires. They help planners determine possible enemy movement rates, choke points, or other terrain features where the enemy must slow his movement and/or where he may try to hide his forces. This enhances the friendly forces' capability to detect and engage the enemy with long-range indirect fires. The DTSS and Terra-Base systems are also excellent tools to help planners determine the best locations for observation posts and routes to these posts. They expedite the normal combat calculations and allow the commander to mass quickly and to apply overwhelming combat power at the decisive place and time. Scoring: **Graduated T, P, U**

Terrain analysis in obstacle planning. The information provided by DTSS facilitates identification of the best locations for obstacles to effectively tie in with the natural terrain and the friendly direct fire plan. It enables the placement of the obstacles where they will have the greatest impact on the enemy's maneuver and may even deny the enemy a particular maneuver option. It is critical in planning the location and emplacement of dynamic minefields. Improved terrain analysis tools also permit digitized units to more accurately estimate enemy movement rates and locations. This, coupled with a more accurate estimate of the time needed to execute a dynamic minefield, provides the digitally equipped commander a decisive advantage over his analog counterpart. Scoring: **Graduated T, P, U**

Combat Service Support (CSS) operations. Another digital tool the brigade uses in the planning phase is CSSCS. This system tracks the logistical posture of the brigade. It gives the commander and his staff an accurate estimate of what assets are currently available, when additional assets will be available, what the estimated combat power will be at the start of the operation, and what the estimated casualties will be. This detailed CSS information facilitates transition to a new mission or the next phase of the current mission. The CSSCS enables the staff to determine the resources and activities required to set conditions for successful control of friendly contact with the enemy. For example, it can confirm that adequate mortar ammunition is on hand to fire the targets required to fix an enemy force over an anticipated period of time. It can also determine if sufficient fuel is on hand to enable committed companies to maintain contact with a moving enemy force. The CSSCS interfaces with FBCB2 platforms and can receive immediate LOGSTATs, PERSTATs, and Commander SITREPs (situation reports). Scoring: **Graduated T, P, U**

Both DTSS and FBCB2 also support CSS operations by (a) reducing the time needed to choose routes, logistic resupply points, and location of medical assets, (b) updating CCIR, and (c) showing commanders where they are accepting risk.

Preparation Phase

During this phase the friendly force shapes the battlefield so that it can make contact with the enemy where, when, and how it desires. Commanders and their staffs build on the actions accomplished during the planning phase, step up efforts to gather information on the enemy, and ready their elements of combat power. They adapt their plan as necessary to adjust to enemy actions or to seize fresh opportunities. Key activities are described in the following paragraphs.

Echeloned reconnaissance. The brigade will employ reconnaissance assets to fill information gaps during the preparation phase. It is important to note that while most of the brigade is posturing forces, conducting logistical operations, and conducting rehearsals, the BRT, along with the battalions' scout platoons, will move into the execution phase of the brigade's R&S plan. Corps or division reconnaissance units may be conducting related operations at the same time. Intelligence collection will always go on simultaneously and must be closely coordinated with reconnaissance.

Conducting reconnaissance efficiently requires advanced tactical skills, especially in light of the larger AOs assigned to digitized units. Commanders must identify their CCIR, assign primary and alternate collection means, and synchronize collection over time/space to keep the COP up to date. This means that the brigade R&S plan must be echeloned or "layered" with different types of collection assets to ensure that the critical Targeted/Named Areas of Interest (TAI or NAI) are observed and that information can be passed in a timely fashion.

An example of this would be the plan to observe a single TAI. Observers could include standoff sensors or division reconnaissance for early detection, a STRIKER from the BRT, and an alternate in the form of a task force (TF) scout. The next layer could include the company/team Fire Support Team Chief with an alternate being a tank platoon leader. All would be linked via FBCB2, with the fire support observers having additional systems such as the FOS, Fire Support Team Vehicle (FISTV), Long Range Advanced Scout Surveillance System (LRAS3) and Mini Eyesafe Laser Infrared Observation System (MELIOS). Enemy entering the TAI could ultimately be attacked through an indirect fire mission initiated by a BRT request that goes from the brigade AFATDS, to the direct support battalion AFATDS, to the battery AFATDS/Battery Computer System, to the platoon Automated Fire Control System. The brigade UAV, validating target effects as reported by the BRT scout, could provide battlefield damage assessment (BDA).

The handover from reconnaissance to main force units requires detailed coordination, which is considerably easier in an FBCB2-equipped force. Reliable communications connectivity and tactical handoff of approaching enemy units are vital to successful force tracking.

The reconnaissance information facilitates the COP and situational understanding throughout the operation. With the feedback from the R&S effort, plans for initial actions solidify. A critical condition for controlling the friendly forces contact with the enemy—knowing where the enemy is and determining what he intends to do—begins to develop.
Scoring: **Graduated T, P, U**

Shaping the battlefield. Elements of shaping the battlefield include defining the unit's goals, determining how to achieve those goals, determining what the enemy can do to hinder friendly efforts, and determining actions to mitigate the enemy's capabilities. Shaping actions address both enemy and friendly activities. For friendly forces these actions include organization, movement and positioning of forces, seizing or securing key or critical terrain, employing obstacles, infiltrating scouts or other observers, jamming, coordinating and delivering deep fires, and related logistics actions. Regarding the enemy, actions include determining what

his likely courses of action (COAs) are and taking steps to deny one or more of those COAs. To shape the battlefield the commander must establish observation of his AO in depth, dispose his force for maximum flexibility and speed of action, and gain control of decisive terrain that limits the enemy's options.

As an example, consider the brigade's early employment of dismounted infantry to seize a piece of key terrain that causes the enemy to fight for it or to take an action that will facilitate decisive operations by the main maneuver forces. Another example of a shaping action is the execution of the brigade's deep battle with its indirect fire and electronic warfare assets. The objective here could be to disrupt the enemy's movement, separate his forces, or strip away logistical assets.

Shaping the battlefield takes place in conjunction with and supports the R&S plan. The impact of these operations must be determined and provided back to the leadership in the brigade to enable decisions about future enemy contact. Scoring: **Graduated T, P, U**

Rehearsals. All command levels from platoon through brigade conduct rehearsals. These rehearsals are guided by doctrine/TTP/SOP in terms of type, content, focus, and timing. According to battle staff doctrine (U.S. Department of the Army, 1997), the purpose of the rehearsal is three-fold. First, rehearsals allow participants to practice, to one degree or another, a selected battlefield activity and synchronize combat, combat support and combat service support assets for maximum battlefield effect. Second, the rehearsal affords participants a means to visualize the battlefield and better understand the commander's intent. The final purpose is for participants to discuss as yet unplanned responses to enemy actions or battlefield opportunities.

Doctrine gives no insight into what digital C2 aspects should be addressed during the rehearsal nor does it specify any task, conditions, or standards for a digital rehearsal. To maintain digital connectivity, commanders must understand lower TI architecture and know the tools required to establish and maintain connectivity throughout their operations. These elements should be included in rehearsals.

Two examples provide insight. First, EPLRS (Enhanced Position Location Reporting System) generally out-ranges SINCGARS, even though both are line-of-sight systems. The SINCGARS is an FM radio system, while EPLRS is a linked digital communication system. At certain stages of the fight, commanders may lose voice (SINCGARS) contact with each other. By transmitting FBCB2 free text messages over EPLRS, the range limitations of SINCGARS can be offset. Positioning retransmission elements is another way to compensate for movement of the force and should be discussed as part of the rehearsal. In any case, brigade rehearsals should address the method to be used to preserve voice communications and the switch from FM to pure digital messaging if necessary.

The second example of how to maintain connectivity is the use of "Radio Net Join." Once units pass beyond the SINCGARS and EPLRS line-of-sight range, connectivity with their parent unit is broken. This condition can be overcome through understanding the TI architecture and using the FBCB2 Radio Net Join function. This function allows a unit to transparently join a SINCGARS net or EPLRS architecture for the purposes of passing data (SA and C2 messages).

For example, the task force scouts can Radio Net Join to the BRT to maintain connectivity with the task force. Bringing this out at the rehearsal alerts commanders to the need to maintain connectivity and watch for "transient" elements. Essentially, this is nothing more than extending the signal officer's C2 rehearsal script to element commanders. Scoring: **Graduated T, P, U**

Digital rehearsal. Commanders may opt to conduct a digital rehearsal in place of a regular rehearsal under certain conditions (e.g., when forces in contact prevent a commander's withdrawal to a terrain model rehearsal site). Currently digital rehearsal tools are only available at the brigade level in the form of the BPV. At the battalion level and below, a digital rehearsal is a combination of map and radio rehearsal, with the FBCB2/MCS screen taking the place of the map. The staff (or commander) builds overlays depicting selected critical battlefield events. At the appropriate time, elements bring up the overlays and respond per unit SOP to the displayed situation. The same script used in a "normal" terrain model rehearsal can be used during the digital rehearsal (i.e., enemy capability, intent and location, task organization, current combat power, movement formation/techniques, task and purpose, direct fire control measures, fire support observation status, etc.). This type of rehearsal should at least be planned for and addressed in the unit SOP. Scoring: **Graduated T, P, U**

Logistics operations. From a CSS point of view, logistical resupply is an ongoing and continuous operation across all mission phases. However, CSS functions come into special focus during mission preparation, especially when the operation requires special levels or types of supplies (most commonly ammunition or barrier materials or unusually larger fuel stocks). Units build or update the electronic database of on-hand supplies by sending/rolling up FBCB2 LOGSTAT reports. In the same fashion, the FBCB2 PERSTAT report is built and sent up the chain of command. From these initial reports, staff estimates are confirmed or updated and actions taken to adjust the plan and logistical priorities, which will drive post-operation changes. Information will be gathered to aid in logistics tracking and preparation of the battlefield. As part of the plan and the disposition of friendly forces, the brigade may also position resources where they best facilitate the anticipated maneuver. Scoring: **Graduated T, P, U**

Key digital tasks. Some key preparation tasks that help the brigade staff address current and future operations are noted below.

Effect UTO change. The brigade task organization is implemented physically and digitally. Physically, units must link up, exchange status information, and be briefed on associated tasks. Digitally, units must effect linkup to ensure that affiliations reflect the commander's plan. Of key importance is the tracking of accepting the unit task reorganization (UTR) change in FBCB2, and the associated UTO changes in ATCCS. To achieve the fullest battlefield utility, the UTO must be the same across all ABCS systems. Otherwise, linked/rolled up reports generated by the lowest level—FBCB2 equipped platforms—will be discarded by the associated battlefield functional area control system. An example is the interaction between FBCB2 and CSSCS, with respect to LOGSTAT and PERSTAT reports. Both reports are generated by individual platforms and rolled up at platoon and then company levels. If the company rollup (reflecting the initial UTO) does not match the digital UTO reflected in CSSCS, the CSSCS system will not accept the report. The result would be a company's worth of logistical and personnel data lost. Scoring: **Graduated T, P, U**

Track and update CCIR. The CCIR developed and approved during the planning phase should be tracked and reviewed during preparation. Digital TOCs have the capability to electronically display information on a large-screen display or on an overhead projection screen. When displayed in a prominent location, the staff can easily refer to the CCIR during the preparation phase and adjust accordingly. Prominently displaying the CCIR electronically reduces the risk of inadequate tracking and updating of the CCIR. In addition, each BOS manager should have some mechanism for tracking his BOS-related CCIR so he can cue the TOC battle captain when CCIR-related information is received by his BOS element. The CCIR must obviously not only be tracked, but also acted on appropriately. Changes to the CCIR are common during preparation as new enemy information emerges. These changes must be distributed to the staff and units and be reflected in event tracking. Scoring: **Graduated T, P, U**

Execution Phase

Shaping operations. Shaping operations continue throughout the execution phase of the brigade operation. Tactical doctrine (U.S. Department of the Army, 2001) describes shaping operations as actions at any echelon that create and preserve conditions for the success of the decisive operation. Shaping operations include lethal and non-lethal activities conducted throughout the AO. They support the decisive operation by attacking enemy capabilities and forces or by influencing enemy decisions. Shaping operations use all elements of combat power to neutralize or reduce enemy capabilities. They typically occur before, concurrently with, or after the start of the decisive operation. They may involve any combination of forces and occur throughout the AO. Fires in depth, electronic warfare (EW), maneuver that limits enemy freedom of action and mobility/countermobility actions are the chief means of shaping the brigade fight.

Reconnaissance and intelligence collection efforts also remain important during shaping operations. Both must continue throughout the fight if situational understanding is to be preserved. Damaging the enemy in depth to assist in establishing contact on favorable terms depends on continued observation of key NAI/TAI and on employment of fires and dynamic obstacles in depth. Managing direct fire contact in an objective or engagement area requires the same continuous observation along with a transition from observation to attack by a friendly force that initiates contact based on reports of observers. In this case, information has to pass directly from scouts to the commander of the attacking force, and a time-sensitive transfer of responsibility for fires and terrain management from the reconnaissance force to the attacking force must take place.

Continued reconnaissance in depth during the main force fight helps shape the action by clarifying tactical options for the commander and confirming the practicality of anticipated branches and sequels.

Digital C4I systems play a dominant role in shaping operations because they enable commanders to observe the execution of the shaping operations. Success or failure determines if conditions for decisive operations have been achieved. The digital brigade's ability to monitor shaping operations without the delays and errors induced by analog relay reporting (echelon to

echelon) represents a key difference and advantage for the digitized force. The capabilities of ATCCS and FBCB2 also enable commanders to monitor unit execution of decisive operations or any other type operations/tasks and to visualize battlefield opportunities and risks. Scoring: **Graduated T, P, U**

Company/battery/troop acquisition of the enemy. Digital C4I systems are of great importance to maneuver companies/troops and field artillery batteries in controlling contact with the enemy. During decisive operations company/battery/troop commanders plan (on the move if necessary) and execute direct and indirect fire actions that result in the destruction of the enemy and achieve mission objectives. Their ability to view the current COP—including locations of any division, brigade, and battalion elements operating in their zones or sectors—assures their unobstructed movement, encourages close cooperation, reduces risks of fratricide and improves cross-talk and timely updates on enemy actions.

For this analysis, success in moving from SA through situational understanding to situational dominance can be measured by the ability of the company commander to receive Blue and Red SA and quickly translate that information into acquisition of enemy targets by weapon systems (tank, IFV, individual arms, etc.). To do so most effectively, the maneuver companies must move safely and quickly to the vicinity of the enemy, dispose and maneuver their units for positional advantage without effective enemy interference, and obtain direct observation of the enemy where, when, and in the general configuration they expected. If the previous preparatory efforts of the brigade and battalion do not assist company commanders in transitioning from preliminary maneuver to visual/direct fire contact on favorable terms, then higher level support will not assist meaningfully in controlling contact with the enemy. If the company commanders must fight to establish situational understanding and to achieve situational dominance, the benefits of digitization will not be reaped and the friendly force will be at risk of mission failure. Scoring: **Graduated T, P, U**

Monitoring pending enemy contact. Digital C4I systems and the digital skills required at battalion and brigade levels directly support gathering information about the enemy from the COP's portrayal of "computer screen contact." Units in ever-closer proximity to the enemy must refine this information. This leads to the company/battery/troop actions described in the preceding paragraph. The digital skill of building the COP requires a high level of competence. The critical information provided by different battlefield observers, whether digital or analog, must be gathered in time, evaluated and sent to commanders about to make contact. To date, fundamental warfighting principles have not been usurped by a new set of "digital" principles. However, a new skill set (maintaining TOC and unit connectivity, setting filters and warnings properly, etc.) is required to exploit the C4I systems in order to achieve situational dominance at the tip of the spear. This involves employing every resource that is useful in a compressed time period, melding reports from various sources and assuring the best use of time in monitoring and reporting. As contact becomes imminent for the companies, most of the time-sensitive enemy information will be transmitted by voice rather than digitally. Commanders and staff leaders must develop the skill of determining when the transition between digital communications and voice communications takes place. Scoring: **Graduated T, P, U**

Updating the intelligence picture and ISR plan. As the enemy is acquired throughout the battlespace, reports are input via digital systems to update the enemy picture. The results of successfully accomplishing this task are two-fold. The first is the ability to recognize battlefield opportunity and risk. Second is the effect on future plans. For effective intelligence support to their operations, commanders must review and revise CCIR during the fight. The S2 sections at both brigade and battalion echelons will continually monitor friendly and enemy situations, advising leaders of changes in the situation and the impacts on when and where contact can be expected to occur. As units transition out of movement to maneuver and gain visual, then direct fire contact with the enemy, Red SA, is updated to "ground truth" via FBCB2 Spot reports. These Spot reports are sent to the battalion S2 section and analyzed with the aid of ASAS. Once analyzed, the battalion S2 sends an updated ASAS enemy situation template to the brigade. At the brigade, subordinate ASAS templates are analyzed and compiled as part of a continuing intelligence estimate process for current and projected operations. This Red picture is the part of the COP that allows commanders to visualize the battlefield risks and opportunities associated with the changing conditions of the interaction between friendly forces, enemy forces, and terrain. Skills that support this task span brigade and platform levels. They encompass TOC connectivity, unit connectivity, Red icon "handoff" and management, and such mundane (but critical) issues as filter settings. Scoring: **Graduated T, P, U**

Transitioning from movement to maneuver. This is a routine task at battalion level. However, CTC experience (Center for Army Lessons Learned, 1998) indicates it is rarely conducted to standard and precious combat power is lost as units stumble into opposing force (OPFOR) kill sacks/engagement areas. With the appropriate application of FBCB2 skills and leader tactical experience, the transition from movement to maneuver can be anticipated, visualized, and controlled. Company/team commanders can use the enemy situation template, the FBCB2 circular line of sight, and overlay tools to determine the Probable Line of Deployment (PLD). This phase line, as part of the overall company plan, is sent digitally via FBCB2. The commander (both company and battalion) can view on FBCB2 the change in movement techniques and formations as subordinate elements cross the PLD. Outside the CTCs, where zones tend to be larger, commanders will have to anticipate multiple PLDs as their attacks continue to cover ground.

Brigades or battalions initially held in reserve must make special and particularly flexible plans for commitment and for initial contact with the enemy. Typically, these units will move behind committed units in an attack or be positioned in depth behind committed units in defense. Their commitment will normally depend on the progress of the battle. Accordingly, they will have to be prepared for movement on several possible routes, for maneuver in one of several possible areas, and for contact in a variety of possible circumstances. They will have to follow the intelligence situation across the full AO of their parent unit. The FBCB2 will facilitate their movement through the areas of other battalions or companies on assigned routes and keep them up to date on friendly movements. Their initial contact with the enemy may be controlled and fairly clear (as in a reserve occupying a defensive position in depth) or difficult (as in a reserve committed through a penetration to seize a deep objective). In the more difficult cases, reserve units will have to depend on reports of units in contact, on information developed by standoff sensors and on rough estimates of enemy location and activity. Digital battle command tools will help commanders resolve vague situations faster than in the past and manage imminent

contact with rapidly distributed reports and control measures. Reserve unit commanders should still expect to fight more meeting engagements than commanders of initially committed units.

Filter settings are important here. As part of the commander's pre-combat inspection, filter settings should be checked to ensure they comply with the SOP and that aural warnings are set to alert the proximity of reported enemy elements. Scoring: **Graduated T, P, U**

Updating fire support plans. Throughout execution, fire support plans and graphics must be adjusted based on battle conditions. Targets and triggers are adjusted based on intelligence, enemy actions, and friendly maneuver. During execution, this task starts with updates to the COP from top-down (EAB) and bottom-up (FBCB2 equipped platforms) sources. Planned priority fire support targets can be updated for location or changed as enemy high payoff targets (HPTs) are identified. The AFATDS is the primary system for fire support targeting at both brigade and battalion level. As with CCIR, the planned HPT list must be posted and viewed. In the case of AFATDS, the HPT list is an input to the system, thus speeding the recognition and servicing of appropriate fire support missions. The same basic process for establishing the PLD can be used to establish fire support triggers. These control measures can also be transmitted to FBCB2 equipped platforms in the same fashion. Though digital C4I systems are available, commanders still bear the responsibility for clearing fires. Digital C4I systems can provide rapid information for denying a fire mission, but must never be the sole means of clearing fires. Scoring: **Graduated T, P, U**

Updating maneuver plans. Maneuver plans and graphics also must be updated to reflect changes in the enemy and friendly situation. The maneuver of forces, monitored through digital systems, is adjusted to keep forces synchronized and to make or maintain contact under the best possible conditions. (Spot reports of scouts or observation posts in contact and reports from Army attack aircraft and CAS missions are often the last visually based reports available before leading companies make direct fire contact.) Boundaries, support by fire (SBF) positions, attack by fire (ABF) positions, and routes are adjusted based on these observations. As required, RFLs are implemented. Main supply routes (MSRs) are altered or activated and support nodes are emplaced/displaced based on battlefield events that can largely be tracked through digital systems. The key systems affecting success are the hundreds of FBCB2 equipped platforms, SINCGARS/EPLRS, MCS, ASAS, Mobile Subscriber Equipment and Near Term Digital Radio (NTDR). These are the systems that link to each other and store and pass Red and Blue SA information. However, once the picture is displayed on an FBCB2 screen or Large Screen Display in the TOC, the commander must still be able to rapidly analyze spatial relationships, current combat power status, and mission objectives to arrive at the appropriate decision. Scoring: **Graduated T, P, U**

Updating obstacles and hazardous areas. Obstacles are adjusted and executed based on the enemy situation, time, and events. Overlays are updated accordingly. Modular pack mine systems (MOPMS), Raptor, Gator, and VOLCANO provide the brigade commander the ability to shape the battlefield. He can integrate obstacles and fire support to disrupt the enemy before direct fire contact is made.

Because they are rapidly emplaced and can be positioned in response to enemy maneuver, dynamic minefields pose special challenges to SA. When they are employed, friendly units must be made aware of their location, orientation, and duration. The FBCB2 can rapidly disseminate obstacle reports across the brigade. These reports will visually cue leaders of the proximity of the minefields. Additionally, FBCB2 will also provide each FBCB2 equipped platform an audio and/or scrolling marquee warning when a platform comes within 500 meters of a reported minefield. The same can be done for contaminated areas. The Obstacle and NBC reports are "geo-referenced" so that all FBCB2 equipped platforms receive this report in the form of an icon. If the brigade must breach or bypass an enemy obstacle a similar report can be sent (FBCB2 Bridge report). This report populates the brigade FBCB2 screens with a bridge icon at the appropriate location, giving leaders a visual cue of where to steer. Once in the general area, the normal "analog" cues (VS-17 panel and lane markers) can be used. Scoring: **Graduated T, P, U**

Updating airspace control measures. In conjunction with updating FSCMs, air space control measures are updated via MCS, AMDWS and FBCB2, as well as FM networks. These updates help assure that Army aviation units supporting the brigade make contact on advantageous terms and avoid inadvertent contact. They also assist in preventing fratricide and in providing effective support for ground forces in the direct fire fight. Scoring: **Graduated T, P, U**

Initiating friendly contact with the enemy. The cumulative brigade and battalion planning, preparation, and execution activities culminate in this sub-task. As the company commander approaches the PLD, he compares the top-down SA and direct reports of scouts or other observers who see the enemy with his own understanding of the battlefield (another instance of the continuous commander's estimate). If these pictures are consistent, the commander can act quickly and in coordinated fashion even if the enemy's actual dispositions and the terrain differ slightly from his earlier understanding. He can modify his basic plan to fit the actual circumstances and to strike the enemy effectively.

If the pictures do not match and the situation is unclear, the commander will adjust his maneuver plan on the move and approach the suspected enemy position more deliberately. If the discrepancy is not significant—say, a matter of enemy orientation or exact positioning—he may not be substantially affected. If there are more serious gaps in information, however, the commander will be forced to deploy to a linear formation earlier, to use supporting fires earlier on suspected enemy locations, and to adopt movement techniques that provide greater general security.

The commander can use FBCB2 to adjust his plan on the move by sharing the COP among the company elements. Rapid visualization and common terms and reference points allow the commander to shift location (from ABF 1 to ABF 2, TIR 236 to TIR 451, etc.), array (from platoon bounding by alternate bounds to successive bounds, echelon left/right, etc.), and/or action (action left or action right). By this point in the operation, time has most likely been fixed by the next higher commander. The first company-sized units to make direct fire contact with the enemy play an important role in assuring that the remaining elements of the battalion/task force have an accurate, confirmed understanding of the enemy. First reports from direct fire

contact give the battalion commander his last—and one of his best—opportunities to adjust details and timing of his plan before his other companies make direct fire contact. In addition to correctly selecting, validating, or modifying time, location, array, and action the commander must also generate FBCB2 Spot reports that accurately portray the enemy he "sees." Successful initiation of contact with the enemy is seen in the seamless transition from observing digital screen displays to acquiring the enemy with weapon system optics. Scoring: **Graduated T, P, U**

Transitioning to subsequent operations. Digital tools provide the potential for significantly reducing the time required for transition to subsequent operations. With a common picture of the battlefield, commanders can rapidly confer, determine a COA, and begin the transition to the next operation as staffs put the plan into writing/graphics and disseminate the information. Under some conditions, the benefits of the COP enable staffs to "skip echelon" as they plan, saving further time. For example, the brigade commander may see that he has a narrow window of opportunity to capitalize on battlefield conditions as a mission reaches its projected end. Having a clear picture of the enemy (top-down, integrated with bottom-up) and friendly situation, he may quickly formulate a plan, disseminate it via FBCB2, collectively brief his battalion and company commanders at a forward location, and conduct back briefs (a form of rehearsal). Subordinate units can begin posturing forces early and leveraging FBCB2 to move sooner and faster, especially during limited visibility. Company commanders can use the planning time normally taken by the battalion (even for parallel planning) to conduct preparation and perhaps execution for certain companies/batteries/troops. The battalion staff conducts critical BOS synchronization (mission dependent) and disseminates the plan via FBCB2 down to company level and via MCS to the brigade. While this is not the routine method of operating, it is a technique for increasing operational tempo, maintaining continuous pressure on the enemy, and taking advantage of battlefield opportunities. Scoring: **Graduated T, P, U**

Summary of Findings for Controlling Contact with the Enemy

For the several phases involved in combat missions, controlling friendly contact with the enemy entails a variety of sub-tasks that benefit directly from digital capabilities. Table 5 lists this project's limited set of sub-tasks for controlling friendly contact with the enemy. In all cases the recommended scoring approach is graduated—reflecting the relative complexity of the various sub-tasks and the long time spans over which they typically are executed. As noted previously, these findings are preliminary and require further study.

Table 5

Measurement Framework for Control of Enemy Contact

Activity	Sub-Task	Scoring
General	Maintaining digital connectivity	Graduated
	Establishing and maintaining the COP	Graduated
	Military Decision Making Process	Graduated
Mission Planning	Intelligence preparation of the battlefield	Graduated
	Terrain analysis in IPB	Graduated
	Terrain analysis in fire support planning	Graduated
	Terrain analysis in maneuver planning	Graduated
	Terrain analysis in obstacle planning	Graduated
	CSS operations	Graduated
Mission Preparation	Echeloned reconnaissance	Graduated
	Shaping the battlefield	Graduated
	Conventional rehearsal	Graduated
	Digital rehearsal	Graduated
	Logistics operations	Graduated
	Implementing UTO change	Graduated
	Tracking and updating CCIR	Graduated
Mission Execution	Shaping operations	Graduated
	Company/battery/troop acquisition of enemy	Graduated
	Monitoring pending enemy contact	Graduated
	Updating intelligence picture and ISR plan	Graduated
	Transitioning from movement to maneuver	Graduated
	Updating fire support plans	Graduated
	Updating maneuver plans	Graduated
	Updating obstacles and hazardous areas	Graduated
	Updating airspace control measures	Graduated
	Initiating friendly contact with the enemy	Graduated
	Transitioning to subsequent operations	Graduated

RELEVANCE OF FINDINGS TO THE FUTURE COMBAT SYSTEMS

Digitization is undoubtedly an essential element of FCS. In addition, FCS will involve the use of robotic sensors and weapons platforms controlled by the users of digital systems. While users of current digital systems are concerned, for example, with tracking their location and that of manned subordinate elements, users of FCS digital systems may be equally or more focused on the location of the robotic platforms for which they are responsible. In many respects, the users of digital systems in the FCS environment are more likely to be overwhelmed by job requirements than their counterparts in the current digital environment, unless digital systems evolve to aid the system user.

This report describes how users can employ current digital systems to meet the subobjectives appropriate to reducing fratricides and gaining greater control over how and when contact is made with the enemy. For example, supporting a unit's transition from movement to maneuver is an important subobjective for the objective of gaining greater control over how and when contact is made.

As digital systems evolve as part of FCS development, specific digital system capabilities will change, but most of the desired outcomes (in terms of objectives and subobjectives) will remain the same. Table 6 attempts to illustrate this point by focusing on two desired outcomes for digitization (i.e., subobjectives) deduced from the contents of this report. For the current digital system, the location of minefields is made available to systems collocated with information users (commanders, crews, and dismounted soldiers), in a manner that allows the information to be automatically displayed for the user. Systems alert a user when a minefield is approached. What users in current digitized units must do to make sure alerts are provided is described under the column entitled "Diagnostics for User Employment of Current Digital Systems." If the disseminating and alerting outcomes are not obtained, this is likely to be due to a failure of users to take these actions. The column labeled "Diagnostics for User Employment of Hypothetical FCS" assumes that FCS will employ a greater degree of automation to reduce the workload of users. In this hypothetical example, FCS digital systems might automatically display geo-referenced icons for minefields if the user (or a robotic system monitored by the user) comes within 500 meters of a minefield or if the minefield blocks the planned route of the user (or robotic system). The digital system might alert the user by stimulating a pocket vibrator.

The hypothetical FCS capabilities would reduce the work users must do to receive the alert as well as reduce the measurement workload required to apply diagnostics. The ability of digital system users to gain the desired outcomes would improve in three ways. First, more of the close approaches to threats would be associated with successful receipt of threat alerts, because there is less the user must do to insure receipt of the alert. Second, the system can alert the user to the probable need to change routes in time to avoid having to backtrack at a later point. Third, the digital systems help "protect" robotic systems as well as the digital system user. The first two columns in Table 6 help to define measurable goals for designing digital system concepts for FCS. Does the new concept offer the potential for improving performance relative to the desired outcome, and does it reduce the work users must do to obtain the desired outcome? An ongoing effort is focused on identifying desired outcomes stated or implied in this report and

related reports and listing required user interactions with current digital systems to produce a series of tables like that illustrated by the first two columns of Table 6.

Table 6

Desired Outcomes of Digitization and Diagnostics as a Function of Current Digital Systems and Hypothetical FCS Systems

Desired Outcomes	Diagnostics For User Employment of Current Digital Systems	Diagnostics For User Employment of Hypothetical FCS Systems
Location of minefields automatically made available to digital systems collocated with users	**Users report locations of minefields using the Obstacle Report message format**	**Users report locations of minefields using the Obstacle Report message format**
Users automatically alerted when they are close to minefields	**User sets FBCB2 filters to properly receive geo-referenced icons** **Commanders with combat vehicle crewman's (CVC) helmets set filters to turn on audible messages** **or** **Commanders periodically check displays to find out if they are approaching minefields**	**User checks threat vibrator battery and puts vibrator in pocket (Vibrator is triggered if user or immediate subordinates come within 500 meters of minefield or minefield blocks planned route of user or immediate subordinates)**

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Three primary goals drove the research: (1) Describe changes in behavior of units as they digitize, along with the benefits and impacts of those changes; (2) determine if new digital skill requirements emerge at brigade level; and (3) explore the measurement of skill proficiency level and how it relates to unit performance. Meeting these goals provides information that can be used to focus the attention of trainers on critical aspects of unit digital proficiency and avoid the explosive growth in observation requirements that can come with digitization. This report presents the methods and findings associated with the second and third goals.

Tasks for digital operations are not appreciably different from tasks for non-digital operations, except for a few system-oriented tasks. This is not surprising since combat tasks are driven by mission requirements rather than battle command technology (which typically takes the form of combat multipliers rather than fighting systems).

Digital sub-tasks are generally not being documented, either by schools or units. The inability of digital units to maintain tactical SOPs means procedures (closely linked to sub-tasks) are not being institutionalized.

Lacking documentation of digital tasks and skills, the research team's panel of experts drew on analysis of digital operations and their own experience to explore performance and measurement requirements. The findings represent a reasonable start point for the journey ahead. Validation of the findings has yet to be addressed, and it remains to be seen how well the results will support the training needs of digital units.

Basic staff procedures and command and control tasks exhibit negligible differences between brigade and battalion echelons. At the same time, brigade staff operations require more digital knowledge and experience. There is a greater variety of digital systems at the brigade level. Integrating and employing the diverse systems requires additional knowledge and more highly developed digital skills (especially manipulation and integration of data).

The battalion headquarters focuses predominantly on execution of combat activities and reporting of combat information, with secondary emphasis on planning. In contrast, the brigade headquarters is equally involved in planning and in integrating and synchronizing combat activities.

Brigade staff workload is driven, in part, by unique responsibilities. The brigade staff integrates and synchronizes the activities of all organic reconnaissance elements, to include scout platoons. The brigade's ACT executes intelligence analytical functions not found at the battalion level. Establishing the COP is largely the responsibility of the brigade, as is shaping the battlefield. The maneuver brigade reorganization has concentrated some key tasks at the brigade level, most notably R&S planning and planning/directing breach operations.

Digital operations bring a new dimension to FFIR, namely a critical emphasis on managing platform and network functionality and connectivity. Maintaining proper connectivity and high broadcast rates is crucial to building and maintaining the COP. The conditions and standards for meeting digital FFIR requirements vary between brigade and battalion echelons.

Digital tools contribute to preventing fratricide primarily through accurate and efficient dissemination of battlefield information and high levels of situational understanding. Controlling contact with the enemy benefits from rapid dissemination of an accurate picture of enemy and friendly forces, continuous updating of information, digital terrain analysis, and digital wargaming.

Existing approaches for assessing individual and collective proficiency are expected to be suitable for measuring digital skill proficiency. The primary approaches are all-or-none determination and a simple graduated scale (T-P-U). More complicated approaches were judged to be unsuitable. A major advantage of simpler measurement approaches is the extent to which they simplify the job of unit trainers and observer/controllers (O/Cs). It is important to remember that these findings are based on the analysis by the panel of experts, not empirical investigation.

For the various doctrinal forms of contact with the enemy, preventing fratricide involves a few sub-tasks that revolve around digital tools and many sub-tasks that benefit directly from digital capabilities. In most cases the recommended scoring approach is go/no go—reflecting mainly the critical importance of the various sub-tasks.

For the primary phases involved in combat missions, controlling enemy contact entails a variety of sub-tasks that benefit directly from digital capabilities. For the limited set of sub-tasks identified in this project, the recommended scoring approach is uniformly graduated—reflecting the relative complexity of the various sub-tasks and the long time spans over which they typically are executed.

The Army needs a systematic framework for articulating digital tasks, sub-tasks, procedures, and skills. The framework should include general guidelines specifying how digital systems and operations impact tasks and sub-tasks, as well as the interrelationships among these various aspects of digital performance.

In looking across activities with the potential to reduce fratricides, one finds that certain activities are repeated. Such repetitions may be important in identifying high priority measurement requirements and in defining levels of unit digital proficiency. For example, using the FBCB2 NBC1 report or Obstacle Report creates an icon for the appropriate threat that is disseminated network wide and displayed on all FBCB2 screens. Using the Bridge Report and Spot Report, causes icons to displayed showing breach sites and the location of dismounted friendly elements respectively. This information provides additional help in distinguishing between threatening and non-threatening situations. For commanders of various platforms to take advantage of this information they must set their FBCB2 filter settings appropriately. Being motivated to use structured message formats and properly set filters, and knowing how to perform these activities are tasks/skills that contribute to the general skill of "maintain awareness

of own unit relative to threats." Whether a unit employs FBCB2 structured message formats for reporting minefield/obstacles, contaminated areas, breach points, and the location of dismounts is an important target measurement target, because it addresses a mechanism whereby digitization can help address a major problem. If a unit is known to employ these message formats in a reliable manner, then the unit's proficiency level allows the trainer to devote his/her attention to other activities.

Similarly, one finds repeating activities when looking across actions whereby digital systems can help a unit gain control over enemy contact variables. Using FBCB2 terrain analysis tools and enemy situation templates to decide where and when a moving company/team is likely to become intervisible with the enemy provides information that can be used to select advantageous routes, plan for use of smoke and supporting fires, and trigger changes in formation and movement techniques. Using FBCB2 to check the intervisibility situation is an activity that sets the stage for performing many tasks that help give a unit more control over contact variables. Again, this activity warrants measurement and the attention of trainers. A unit that has mastered this activity may be expected to have a level of digital proficiency that should influence measurement efforts.

The many activities that appear to warrant graded measurement also suggests that it may be possible to implement proficiency level concepts that can be used to tailor measurement objectives to fit proficiency levels. The findings of this effort provide raw material that can be used to design and defend concepts for digital proficiency levels.

Barnett et al., (2001) described problems in the performance of analog units at CTCs that might be addressed by the effective application of digital systems, mechanisms whereby digitization can address problems, and digital skills required to apply these mechanisms. Many of the two hundred high-profile problems described in the Barnett report concern fratricides (as broadly defined in the current report) or a lack of control over contact variables. Relating the activities defined in current report to high-profile problems in the Barnett et al. report may be one means of validating these activities. The current report contains selected examples of cases where the application of digitization helps to address performance problems of units at CTCs (e.g., use of digital systems to support the transition from movement to maneuver).

Examples of how the findings in this report can be used by units, trainers, training developers, training strategy developers, training device developers, digital system developers, and the research/development community are listed below.

- Training developers can identify digital activities that need to be addressed by programs of instruction (e.g., use of digital systems to support the transition from movement to maneuver).

- Training developers can identify processes or outcomes that need to be addressed by performance standards (e.g., company commanders identify the probable line of deployment and communicate the results to subordinates).

- Given performance standards, training strategy developers and the research/ development community can gain a greater understanding of how training devices can be designed and applied to support necessary practice opportunities (e.g., the setting must provide company commanders with the digital information flow needed to predict the probable line of deployment and time to make and act upon such predictions).

- Given standards and a description of the settings in which standards are likely to be applied, the information can be used to decide how to apply automation in analyzing ground truth data (e.g., snapshot showing a unit's formation as it crosses the probable line of deployment) and digital communications (e.g. which echelons and BOSs have access to a company's probable line of deployment) to provide units with timely feedback.

- Digital system developers and digitized units can use performance standards to guide the evolution of digital systems and TTPs (how can we reduce the time to decide and/or disseminate the location of the probable line of deployment or increase the accuracy of the decision?).

Recommendations

The findings of this project form a preliminary database that speaks to measuring digital skills proficiency. Much work lies ahead to expand the database so it can fully support the training development needs of the digital force. The authors recommend the steps listed below.

- ♦ Establish a comprehensive framework to guide the documentation of digital tasks, sub-tasks, procedures, and skills.
- ♦ Capture the digital sub-tasks and procedures emerging within digital units.
- ♦ Expand the analysis of digital skills by applying task analysis methods in operational environments.
- ♦ Establish a digital training laboratory to support the systematic investigation of future force performance and proficiency assessment needs.
- ♦ Continue the investigation of inter-echelon differences in digital performance requirements and conditions.
- ♦ Extend the analysis of digital proficiency assessment requirements to the Objective Force.
- ♦ Review the literature on measuring skill proficiency to identify promising approaches for the digital performance environment.
- ♦ Determine "best practices" among industry, academia, and other military services for measuring digital skill proficiency.
- ♦ Develop a comprehensive model for characterizing and measuring the various types of digital skills and knowledge.
- ♦ Compare the utility and effectiveness of alternative approaches for measuring digital skill proficiency in operational settings.

The research findings of the MEDD project pave the way for measuring digital skills proficiency. However, the results provide merely a point of departure. A significant amount remains to be learned through follow-on research. Expanding the knowledge base is an

important step for optimizing the warfighting proficiency of the future force**.** Three lines of research will build upon the current work. First, concepts for digital proficiency levels will be designed and tested in terms of their value in tailoring measurement objectives. Second, measurement procedures needed to assess the digital user tasks/skills described in this and other related reports will be developed. Third, additional information will be developed that will be used to identify events that most warrant the attention of trainers. This line of work will focus mainly on FBCB2, and it will include:

- identifying those FBCB2 information applications (e.g., decide when and where moving unit will become intervisible with the enemy) and software capabilities (e.g., terrain analysis) that are least and most frequently used by leaders, as a function of experience and echelon:
- finding out why applications and software capabilities are/are not being employed;
- identifying problems in using FBCB2 information applications and software capabilities as a function of experience using FBCB2; and
- identifying gaps in feedback regarding use of application and software capabilities.

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APPENDIX A

INTERVIEW QUESTIONS

1. Changes in Unit Attitudes:

    a. Describe how your attitude toward fighting in the digital battle space has changed over time. Consider the following benchmarks:
        - Initial train-up assessment before the Customer Test (Mar-Apr 00)
        - Post-train-up assessment at the Customer Test (May 00)
        - Initial train-up assessment before NTC rotation (Aug 00)
        - "Hot" post-rotation assessment (Aug 00)
        - Reflective assessment (Apr 01)

    b. What attitude or behavioral changes are fundamental to becoming a digitally trained team? Address the following echelons, as appropriate:
        - Platoon
        - Company
        - Battalion
        - Brigade

    c. What was the role of digitization in the NTC? What value did digitization bring? How could that value have been enhanced?

2. Meeting Digitization Challenges:

    a. What problems did your unit face in using digital systems?

    b. What changes did your unit make to address these problems?

    c. Did your unit use SOP development, staffing changes, or new TTPs to support the use of digital systems? How?

3. Digital Leader Tasks and Skills:

    a. What are the most important digital leader tasks that require training to achieve minimal proficiency?

    b. What leader tasks have changed on the digital battlefield for you?

    c. What basic digital skills are required to accomplish the above leader task(s)?

4. Team Training Tasks and Skills:

   a. After "knobology," what are the primary/basic digital training tasks for various teams?
      - Staff integration management
      - TOC battle command management
      - Platoon
      - Company
      - Battalion
      - Brigade

   b. What different/unique skills are required to be successful performing with digital information as opposed to analog at various levels?
      - Platoon
      - Company
      - Battalion
      - Brigade

   c. What new knowledge, skills, and abilities are required to accomplish the digital infrastructure management, operations, and maintenance tasks?

5. Exploiting Digitization:

   a. Describe the differences between digital and analog mission accomplishment and how you ensure success at your team level. What must you do differently now to exploit digitization?
      - Management of time and resources
      - Decision making
      - Understanding the Commander's intent (objectives, key information needs, empowerment)
      - Communications and information management

   b. What specific digital leader skills are necessary to exploit the advantages of digitization?

   c. How do you know a unit is 'digitally' better? How do you assess progress?

   d. What changes have you noticed, due to digitization, in terms of what you have to do or what you can do for mission planning?

   e. Do you think that digitization gives you greater access or less access to the commander, other BOS, and higher and lower echelons, or do you think it has no effect on access?

   f. Does digitization help you do your job, or does it add to the variety of activities/tasks you have to attend to?

   g. If you could have a tool that automatically tracked digital planning activities and alerted you to problems, what activities or problems would you want the tool to track?

h. Did you use digital systems to implement changes in mission planning, preparation and conduct, or do you rely more on voice or face-to-face communications?

i. Do you use digital systems (directly or indirectly) to track how well staff members are working together in planning for a mission? If so, what do you pay attention to?

j. How do you use digital systems to manage execution of the reconnaissance and surveillance plan?

k. What changes has the unit made over time to speed up preparation of the R&S plan or improve the quality of the plan? Have there been any SOPs developed about who should provide what information and when?

l. Do digital systems help the process of analyzing data? If so, how? Do they make it easier to obtain data and to disseminate the results?

m. How did your unit apply the doctrine and TTPs for digital operations?

n. Where does the doctrine or TTP appear flawed?

o. What shortfalls in digital capability exist?

p. How do soldiers/leaders overcome these flaws?

6. Digital Skills Unique to the Brigade Echelon:

a. Are there unique digital skills at level that are not learned at lower echelons?

b. Are those skills significantly different for any subset of the TOC? Which ones?

c. How are those skills unique to the level?

7. Proficiency Concepts:

a. How would you measure proficiency in the brigade-unique skills?

8. Maintaining Tactical Adaptability:

a. What are the new digital sub-tasks required to maintain tactical adaptability at Battalion level?

b. What skills are necessary to be successful in maintaining tactical adaptability?

c. What skills are important in maintaining situational awareness?

d. How would you assess progress and determine proficiency in those skills? Go/no go or multi-value measures? How so?

e. Is there a different level of proficiency required at level in maintaining tactical adaptability?

9. Controlling Enemy Contact:

a. What new digital sub-tasks are required to control enemy contact at Battalion level?

b. What skills are necessary to be successful in controlling enemy contact?

c. How would you assess progress and determine proficiency in those skills? Go/no go or multi-value measures? How so?

d. Is there a different level of proficiency required at level in controlling enemy contact?

10. Preventing Fratricide:

a. What new digital sub-tasks are required to avoid fratricide at the Battalion level of decision-making?

b. What skills are necessary to be successful in avoiding fratricides? Which skills are digital related?

c. How would you assess progress and determine proficiency in those skills? Go/no go or multi-value measures? How so?

d. Are there unique digital skills required at the level to avoid fratricide?

11. What other comments do you have about digital tasks and skills?

a. If you had only five minutes to tell your replacement what he needs to know about operating in a digital environment, what would you tell him?

12. Digital Operations at the Company and Platoon Level:

a. Does FBCB2 support the control and distribution of direct fires? If so, how?

b. Do crews use FBCB2 to prepare and submit range cards? Do they view range cards as offering greater value or less value in the digital environment?

c. Are terrain analysis tools used to select or check movement routes? If so, who does the checking?

e. Is FBCB2 used in any way to deconflict routes? If so, how?

f. How do you use FBCB2 to control unit movement?

g. Do you use FBCB2 during movement prior to contact? If so, how?

h. Once you have engaged the enemy (or vice versa), do you use FBCB2? If so, how?

i. How does digitization affect or change the way you conduct troop leading procedures in your unit?

j. Has digitization changed what you as a company commander or platoon leaders emphasize during mission planning, preparation, and mission execution? Has digitization made your job easier or harder? Please explain.

k. How has digitization affected/changed the duties/activities of your track commanders during mission planning, preparation and execution?

l. Do you have a unit SOP that specifies when LOGSTAT reports are sent up by crews?

APPENDIX B

LIST OF DOCUMENTS REVIEWED

The documents listed below were reviewed as part of the data collection effort. Copies of Fort Knox Special Manuals and Fort Knox Special Texts can be obtained through the United States Army Armor Center and School, Fort Knox, Kentucky 40121. Other documents are available from TRW Inc., 100 E. Central Texas Expressway, Suite 200, Killeen, Texas 76541.

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APPENDIX C

ACRONYMS AND ABBREVIATIONS

1CD	1st Cavalry Division
4ID	4th Infantry Division
A2C2	Army Airspace Command and Control
ABCS	Army Battle Command System
ABF	Attack by Fire
ACT	Analysis and Control Team
ADA	Air Defense Artillery
AFATDS	Advanced Field Artillery Tactical Data System
ALOC	Air Lines of Communications
AMDWS	Air and Missile Defense Work Station
AO	Area of Operations
ARI	US Army Research Institute for the Behavioral and Social Sciences
ASAS	All Source Analysis System
ATCCS	Army Tactical Command and Control System
AWE	Advanced Warfighting Experiment
BCIS	Battlefield Combat Identification System
BCT	Brigade Combat Team
BDA	Battlefield Damage Assessment
BOS	Battlefield Operating System
BOIP	Basis of Issue Plan
BPV	Battle Planning and Visualization

BRT	Brigade Reconnaissance Troop
C2	Command and Control
C4I	Command, Control, Communications, Computers, and Intelligence
CAS	Close Air Support
CATS	Combined Arms Training Strategy
CCIR	Commander's Critical Information Requirements
CGS	Common Ground Station
COA	Course of Action
COP	Common Operating Picture
CP	Command Post
CSS	Combat Service Support
CSSCS	Combat Service Support Control System
CTC	Combat Training Centers
CVC	Combat Vehicle Crewman's
DCX	Division Capstone Exercise
DS	Direct Support
DTSS	Digital Topographic Support System
EAB	Echelons Above Brigade
EAD	Echelons Above Division
EPLRS	Enhanced Position Location Reporting System
EW	Electronic Warfare
EXFOR	Experimental Force
FBCB2	Force XXI Battle Command Brigade and Below

FCS	Future Combat System
FDD	First Digital Division
FFIR	Friendly Forces Information Requirements
FISTV	Fire Support Team Vehicle
FM	Frequency Modulated
FOS	Forward Observer System
FSCM	Fire Support Control Measures
FSO	Fire Support Officer
GPS	Global Positioning System
HPT	High Payoff Targets
HUMINT	Human Intelligence
IFF	Identification Friend or Foe
IFV	Infantry Fighting Vehicle
IP	Intervention Point
JSTARS	Joint Surveillance Target Attack Radar System
LOGPAC	Logistics Package
LOGSTAT	Logistics Status
LOS	Line of Sight
LRAS3	Long Range Advanced Scout Surveillance System
MCS	Maneuver Control System
MDMP	Military Decision Making Process
MEDD	Measuring the Evolution of Unit Digitization and Digital Skills Proficiency
MELIOS	Mini Eyesafe Laser Infrared Observation System

MLRS	Multiple Launch Rocket System
MOPMS	Modular Pack Mine Systems
MSR	Main Supply Route
MTP	Mission Training Plan
NAI	Named Areas of Interest
NBC	Nuclear, Biological, and Chemical
NCO	Non-Commissioned Officer
NCOIC	Non-Commissioned Officer In Charge
NTC	National Training Center
NTDR	Near Term Digital Radio
O/C	Observer/Controller
OPFOR	Opposing Force
PERSTAT	Personnel Status
PLD	Probable Line of Deployment
R&S	Reconnaissance & Surveillance
RFL	Restricted Fire Lines
SA	Situational Awareness
SBF	Support by Fire
SINCGARS	Single Channel Ground and Airborne Radio System
SITREP	Situation Report
SME	Subject Matter Expert
SOP	Standing Operating Procedures
SSRU	Simulator Systems Research Unit

STRICOM	U.S. Army Simulation, Training and Instrumentation Command
TAI	Targeted Areas of Interest
TF	Task Force
TI	Tactical Internet
TIM	Tactical Information Manager
TIMS	Tactical Information Management System
TIRS	Terrain Index Reference System
TOC	Tactical Operations Center
T-P-U	Trained – Practice - Untrained
TRADOC	US Army Training and Doctrine Command
TTP	Tactics, Techniques, and Procedures
UAV	Unmanned Aerial Vehicle
UTO	Unit Task Organization
UTR	Unit Task Reorganization
VTC	Video Teleconferencing
WIN-T	Warrior Information Network-Terrestrial
XO	Executive Officer